PANE

NEWSLETTER

Volume 7 Issue 1 April 2026

Physics Academy of North East (PANE)

Time is Universe

"Physics: It's about time"

Editor: Nabendu Kr. Deb

In This Issue ...

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President's Message

I am very happy to announce that the annual publication of PANE Newsletter, Vol.7, No.1, April 2026, will be released on the 28th Foundation Day Celebration of Physics Academy of the North East (PANE), to be held on 6th April 2026 at Gauhati University. This Newsletter provides important activities of PANE during last one academic year, 2025-26, including innovative new ideas and knowledge in the field of physical sciences.

PANE Newsletter is providing a mouthpiece of the Academy and also a platform for the exchange of thoughts for all members of the Academy. Timely publication of PANE Newsletter, Vol.7, No.1, April 2026, once again proves the resilience, continuity and stability of the existence of the Academy on its 28th Foundation Day celebration. The editor and his editorial team are making relentless efforts to publish this piece on time. The present issue of the Newsletter will serve as a good addition to learning and reading material to our esteemed members of the Academy.

Long live PANE and its publication PANE Newsletter.

Dr. N. Nimai Singh

General Secretary's Message

The Physics Academy of the North East (PANE) has expanded its academic and outreach activities in the last couple of years with the objective of promoting physics education and research across Northeast India. Continuing from the last year, PANE has conducted several regular programmes that serve as important platforms for interaction among students, teachers, and researchers and has taken various other initiatives.

One of the key academic activities of PANE is the organisation of the Regular PANE Conferences, which are now held annually. These conferences bring together physicists from universities, colleges, and research institutions, providing opportunities to present research work, exchange ideas, and interact with leading scientists. In addition to these conferences, PANE is conducting thematic Summer and Winter Schools, which are particularly valuable for students and young researchers. These schools provide focused training in specific areas of physics and create opportunities for close academic interaction with distinguished scientists and experts in the field.

PANE also now runs outreach programmes aimed at motivating young students to pursue careers in science. Among these initiatives, the North East India Physics Talent Search (NEIPTS) has emerged as a significant programme. NEIPTS is designed to inspire school students to develop a deeper interest in physics and scientific research and identify talented students from across the region.

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General Secretary's Message

In order to recognise excellence and encourage scientific contributions from the region, PANE has started conferring several prestigious recognitions. These include the PANE Young Scientist Award and the PANE Woman Scientist Award, which honour promising researchers from Northeast India who have made notable contributions to physics. In addition, distinguished physicists of the region who have rendered outstanding service to physics and science education are elected as Fellows of the Physics Academy of the North East, a recognition that acknowledges their achievements and inspires the next generation of scientists.

PANE has also taken initiatives to support academic publishing. The Academy facilitates the publication of scholarly books in collaboration with established publishing houses. This collaboration is undertaken purely in an academic capacity, without any financial involvement from the Academy and without any financial commitment, such as publication charges, from the authors. Furthermore, PANE publishes peer-reviewed journals, including the PANE Journal of Physics and the PANE Journal of Physics Education, which provide important platforms for disseminating research findings as well as innovative pedagogical approaches in physics education.

On the organisational front, several administrative and measures have also been undertaken in recent years. The regular renewal of the Registration Certificate has been ensured, PANE PAN card is obtained, and the various databases of PANE are now being systematically maintained. Regular financial audits are conducted, and strengthening the financial standing of the Academy has been given significant emphasis. As part of enhancing the visibility of the organisation, a Wikipedia page for PANE has also been created.

In addition, a delegation of PANE recently met the Shri Ranoj Pegu, the Education Minister of Assam, to seek support for the establishment of a permanent office for the Academy. Such institutional developments are expected to contribute to the long-term growth and stability of PANE.

These initiatives represent important steps in strengthening the activities and outreach of the Academy. All these and more will hopefully continue in years to come with the next general secretary and the new members of the Executive Body, further advancing the mission of PANE in promoting physics education and research in Northeast India.

Dr. Samrat Dey

News ...

⟶ ISSN no. assigned to PJP

PANE Journal of Physics has been officially assigned its International Standard Serial Number (ISSN 3107-9342), which marks a significant milestone in the journey of any scientific academy. This could have been possible due to the invaluable contributions by Prof. N. Nimai Singh, the Editor-in-Chief, for his constant encouragement throughout the process, and the Editors, Dr. Debasish Bora and Dr. Debajyoti Dutta, for their dedicated efforts in fulfilling the various stringent requirements. General Secretary of PANE, Dr. Samrat Dey extended his sincere appreciation to all members of the Board of Editors for this achievement.

Events ...

27th Foundation Day of Physics Academy of North East:

27th Founday Day of Physics Academy of North East (PANE) has been celebrated at KBR Auditorium, Cotton University, Guwahati, jointly organized by the Department of Physics, Cotton University and PANE on 7th April, 2025, marking a significant milestone for the organisation. The event featured a series of important highlights, including the Foundation Day Lecture, the launch of the PANE Journal of Physics (PJP) (where 7 numbers of high-quality research have been published), and the unveiling of the PANE Newsletter (Volume 6, Issue 1). In this special occasion, the academy has invited Prof. Ramesh Chandra Deka, Vice Chancellor, Cotton University, as the chief guest who inaugurated the event after delivering inaugural address. The event was anchored by Dr. Pranab Jyoti Bhuyan, and key dignitaries present included Prof. N. Nimai Singh, Prof. J. J. Das, Head, Department of Physics, Cotton University, and Dr. Samrat Dey, who all addressed the audience. Dr. Dey presented the description of the activities carried out by the PANE. Dr. Dey also later presented the list of inaugural PANE Fellows of 2024 and the appointment procedure for the Fellows of PANE. The PANE Fellows includes Prof. Bhupendra Nath Goswami, Prof. Jitendra Nath Goswami, Prof. Dhruba J. Saikia, Prof. Sudhakar Panda, Prof. Soumitra Sengupta, Dr. Raghumani Singh Ningthoujam, Prof. Joyanti Chutia, Prof. Prabodh Shukla, Prof. Dilip Kumar Choudhury, Prof. N. Nimai Singh, Prof. Pravat Kr. Giri, Prof. Bipul Bhuyan, Dr. Bibhas Ranjan Majhi and Dr. Debasish Borah. The academy is fortunate to have Prof. Soumitra Sengupta, Amal Kumar Raychaudhuri Chair Professor at the Indian Association for the Cultivation of Science (IACS), Kolkata, to deliver the Foundation Day talk on the topic "Quantum Mechanics in Gravity". Prof. Sengupta has delivered an excellent talk explaining how the gravity works at the quantum level—such as inside black holes or during the early universe. Current theories struggle because quantum mechanics treats forces probabilistically, while gravity is described as smooth spacetime curvature.

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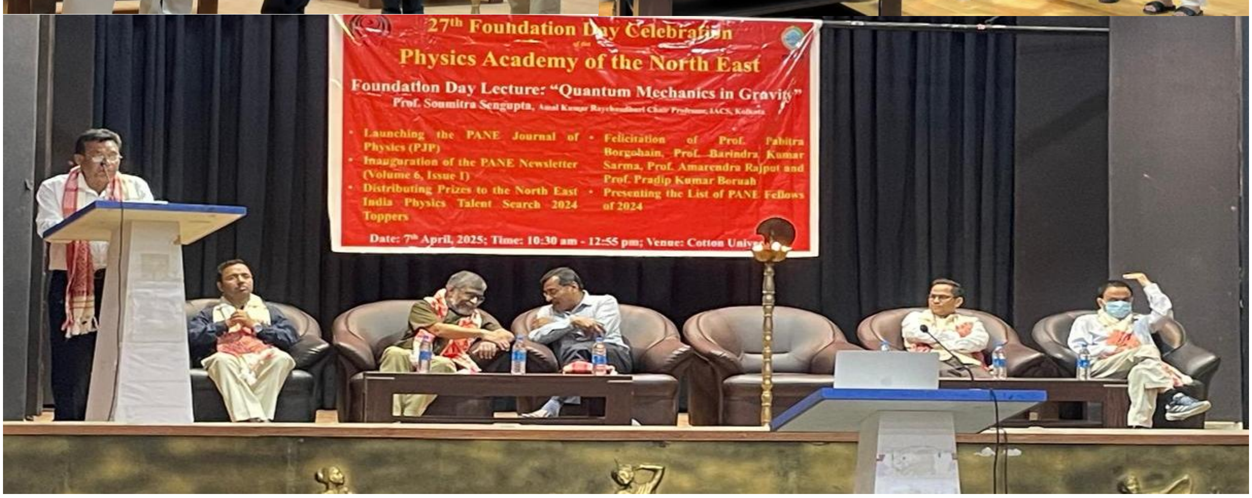
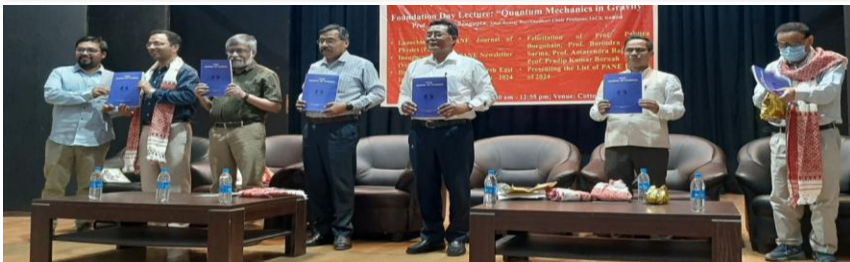


Events ...

Scientists explore ideas like Quantum Gravity, including approaches such as string theory and loop quantum gravity, to bridge this gap. Following the lecture, an engaging interactive session was held, allowing the audience to delve deeper into the subject and interact with the distinguished speaker. Dr. Devabrat Mahanta, Physics Department, Pragjyotish College, has introduced the speaker. The session has been chaired by Prof. Debojit Sarma, Cotton University. The event also included the recognition of the top performers in the North East India Physics Talent Search (NEIPTS) 2024. The prizes were presented by Prof. Kushal Kalita. The winners of the competition were Dibya Priyam Saharia, Ayudh Baruah, Bhargav Ranjan Das, Adi Dohutia, Diana Chongtham, Priyadashini Nongmaithem, Sourav Das, Prayas Madhur Gogoi, Wahengbam Yaiphaba Singh, Shlok Singh, and Mashiman Shinglai. Additionally, several eminent physicists were felicitated for their significant contributions to physics teaching and research. These include Prof. Pabitra Borgohain, Prof. Barindra Kumar Sarma, Prof. Amarendra Rajput, and Prof. P. K. Boruah. The event also featured a presentation on PANE's achievements over the past financial year, which highlighted notable financial growth, membership expansion, the successful completion of the 14th PANE Regular Conference, and the publication of conference proceedings and books. Additionally, key amendments to the PANE constitution were discussed. Other notable attendees include Dr. Ranjan Kalita, Dr. N. Deb, Mr. Parag Bhattacharya, who introduced the eminent physicists to be felicitated; Dr. Debajyoti Dutta, Editor of the PANE Journal of Physics. A large number of students and faculty from various institutions across the Northeast participated in the event, both online and offline, making it a memorable occasion for the regional physics community. The event has ended with a group photo and refreshments for all.



Events ...

⟶ North East India Physics Talent Search (NEIPTS) Exam, 2025:

The NEIPTS Examination began with a simple but profound observation by the PANE—there was no single platform that brought together and identified young physics talents across the north-eastern region of India. NEIPTS was thus conceived in 2024 for identifying the untapped young potentials of the region, for whom the path to global stages like the International Physics Olympiad often felt out of reach. The goal was never just to hold a competition, but to ignite a cultural shift toward scientific inquiry. The program started by bringing the expertise of premier institutions directly to the doorsteps of students across the eight north-eastern states. In the past, high-level mentorship from places like the IITs was a distant dream. But today, it is the cornerstone of the NEIPTS experience, with people like Dr. Debasish Borah and Prof. Bipul Bhuyan of IIT Guwahati, both fellows of PANE, leading academic sessions that transformed complex, national-level standards into accessible, inspiring lessons for students.

Building on this foundation, the second chapter of this journey unfolded as PANE successfully concluded the NEIPTS 2025 Examination. Under the dedicated coordination of Dr. Yajnya Sapkota, the initiative expanded its reach to include students from Classes 9–12, ensuring the spark of curiosity is caught even earlier. The path to discovery followed a meticulous two-stage process: it began on November 9, 2025, with a broad MCQ-based assessment across nearly 50 centers, followed by an intensive interview phase for the top 100 merit-listed students. This second stage was designed to look beyond the scores, evaluating the analytical depth and problem-solving intuition of the region's most promising minds. On 22nd January, 2026, the final results highlighted a brilliant cohort led by A. Baruah, S. Hazarika, and R. Sana, alongside ten other Outstanding Young Performers [Ayudh Baruah (1st), Samiran Hazarika (2nd), Sayan Goswami (4th), Areedrit Purkayastha (5th), Adi Dohutia (6th), Himanjan Basistha (6th), Sudarshan Das (7th), Prayas Madhur Gogoi (7th), Shivang Saikia (8th), and Dhritismita Baishya (10th) from *Assam*; Rajkumar Prithviraj Sana (3rd) from *Meghalaya*; Binita Debroy (9th) from *Tripura*; and Toijam Roshan Singh (10th) from *Manipur*] who represent the rising scientific spirit of the North East. They will be felicitated in the upcoming 28th PANE Foundation Day. More details (centre and state toppers' list) are available in the website: *https://www.paneindia.org/announcement/neipts-2025-first-stage-results* .

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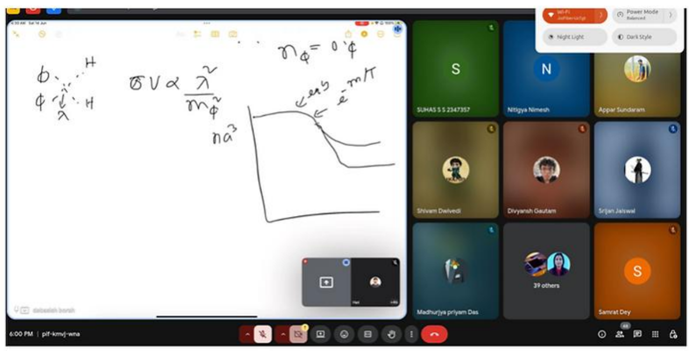
Events ...

North East India Physics Talent Search (NEIPTS) Exam, 2025:

Looking ahead, the story of NEIPTS is transitioning from a regional search into a global pipeline. General Secretary Dr. Samrat Dey has emphasized that the Academy's strategic focus remains on long-term empowerment, aiming to see north-eastern students reach the highest echelons of international competition. To secure this future, PANE has committed to reimbursing registration fees for the National Standard Examination in Physics (NSEP) 2025 and providing continuous mentorship for qualifying candidates. By offering cash awards, formal felicitations with renowned physicists, and a sustainable ecosystem of guidance, PANE is ensuring that the young talents identified today become the pioneering researchers of tomorrow, ready to represent India on the world stage.

Summer School on High Energy Physics

PANE successfully organised Summer School on High-Energy Physics. It was coordinated by Dr. Debajyoti Dutta and Dr. Devabrat Mahanta. This initiative represents a significant milestone, being the first of its kind undertaken by any scientific society in Northeast India. Held online from June 2 to June 14, 2025, the school featured a series of lectures delivered by distinguished experts from premier institutions, including the Indian Institutes of Technology (IITs) and leading universities across the country. The programme encompassed a broad range of topics in high-energy physics, providing participants with an excellent opportunity to deepen their knowledge and engage with cutting-edge research in the field. It is particularly encouraging to note the participation of over 100 research scholars and students from various institutions and universities across India and abroad. Dr. Samrat Dey, the General Secretary of PANE, mentioned that initiatives such as this significantly contribute to the enrichment of the academic ecosystem in the region.



Meeting with Minister of Education, Assam

On the eve of Saraswati Puja, 22 January 2026, a delegation from the Physics Academy of the North East (PANE) presented an idol of Devi Saraswati to the Hon'ble Education Minister of Assam, Shri Ranoj Pegu. During the meeting, the PANE team briefed the Hon'ble Minister on the Academy's academic and outreach initiatives aimed at promoting physics research and education, and fostering scientific temper across the North Eastern region. Copies of the PANE Journal of Physics and the PANE Newsletter were presented, along with selected newspaper reports highlighting the Society's activities. Shri Ranoj Pegu appreciated the contributions and initiatives of PANE. The aim of the meeting is to present a proposal for establishing a permanent office of PANE in Guwahati. In the meeting, an application was submitted seeking allotment of space for a permanent PANE office. The Minister appreciated PANE's efforts and suggested approaching Gauhati University for possible office. Accordingly, a PANE delegation met the Vice Chancellor of Gauhati University and submitted an application. The VC assured that the matter would be placed before the appropriate forum.

The delegation meeting the Education Minister included Dr. Samrat Dey (General Secretary, PANE), Prof. Kushal Kalita (Executive President, PANE), Dr. Ranjan Kalita (Treasurer, PANE), Dr. Debasish Bora (Assam State Representative, PANE), and Dr. Debajyoti Barooah (Former Executive Body Member, PANE). The delegation meeting the Vice Chancellor, Gauhati University included Dr. Samrat Dey, Prof. Kushal Kalita, and Prof. Madhurjya P. Bora (Former Executive Body Member, PANE).



From Cyclotrons to Cures: Alpha-Induced Reactions for Next-Generation Theranostic Radioisotopes

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Abstract

Alpha-induced nuclear reactions are pivotal for producing radioisotopes used in theranostic applications, nuclear structure studies, and astrophysics. This summary consolidates our systematically investigate such reactions through experimental cross-section measurements and theoretical model calculations. Using the stacked foil activation technique at the VECC cyclotron (Kolkata), excitation functions were measured for $^{nat}Cu(\alpha,x)^{66,67}Ga$, ^{65}Zn and $^{nat}Sb(\alpha,xn)^{121,123,124}I$ (E_{lab} = 40–50 MeV). Comprehensive model calculations with the TALYS and PACE-4 codes were performed for a wide range of theranostic isotopes, including ^{52}Fe, $^{66,68}Ga$, ^{73}Se, ^{76}Br, ^{86}Y, ^{90}Nb, ^{110}In, ^{118}Te, and $^{210,211}At$. Optimal nuclear model parameters (optical model potential, level density, pre-equilibrium, photon strength function) were identified to reproduce experimental excitation functions. The results highlight the growing importance of pre-equilibrium processes above 30 MeV and provide validated datasets for medical radioisotope production.

1. Introduction

Radioisotopes are indispensable in modern medicine for both diagnosis and therapy [1, 2]. Alpha particle induced reactions offer unique routes to several theranostic isotopes, yet accurate cross- section data and reliable theoretical models are essential for optimizing production. Our work addresses experimental data above 40 MeV and refines reaction modeling using state-of-the-art codes [3, 4, 5].

Table-1: Target and irradiation parameters.

Parameter	Cu monitor studies	Sb target studies
Target composition	^{63}Cu (69%), ^{65}Cu (31%)	^{121}Sb (57.21%), ^{123}Sb (42.79%)
Thickness (mg/cm^2)	8.96	6.7
Energy range (MeV)	40–50	0–50
Irradiation time (h)	2–4	2–3
Beam current (nA)	∼50	∼50
Monitor reaction	-	$^{nat}Cu(\alpha,x)^{67}Ga$

2. Experimental Methodology

All irradiations were performed at the K-130 Room Temperature Cyclotron, VECC, Kolkata, using the stacked-foil activation technique as shown in Fig. 1 and in Table 1 summarizes the target specifications.

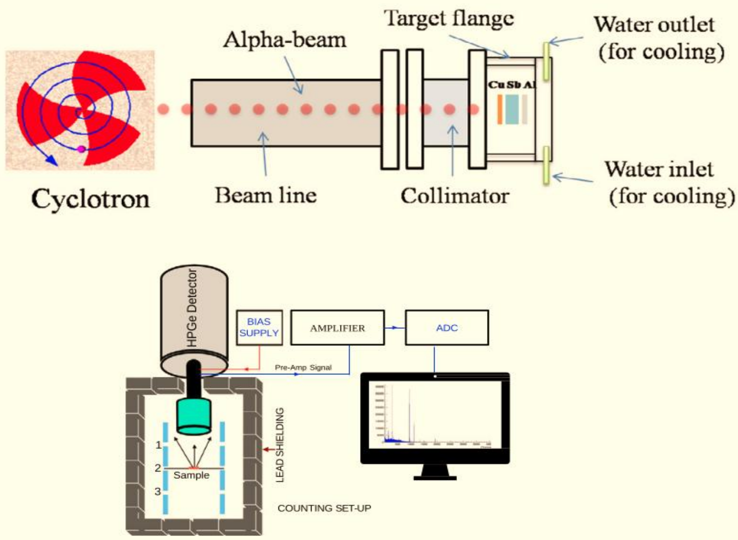

Fig. 1. Schematic representation of the experimental setups for target irradiation and offline counting in the present measurements. The irradiation was carried out at the K130 Room Temperature Cyclotron facility in VECC, Kolkata. The offline gamma - ray counting was also carried out using the passive shielded HPGe detector setup therein.

After irradiation, γ-ray spectroscopy was performed with a 40% HPGe detector. Efficiency calibration employed ^{152}Eu and ^{133}Ba sources. Cross sections were derived using the activation formula:

$$\sigma_{\mathrm{re}}(E) = \frac{A\lambda}{N_0\varphi(\varepsilon_G)\cdot\theta\cdot K_{\mathrm{sac}}[1-\exp(-\lambda t_1)]\exp(-\lambda t_2)[1-\exp(-\lambda t_3)]}$$

where 'A' is the area under the photo-peak of the characteristic γ-ray, 'λ' is decay constant of the produced radioisotope (RI), 'N_0' is the initial number of nuclei present in the target. 'φ' is the beam flux, 'ε_G' is the geometry dependent efficiency, 'θ' is the branching ratio of the characteristic γ-ray, ' t_1' is the irradiation time of the target stack, 't_2' is the time lapse between stop of target irradiation and start of the counting and 't_3' is the counting time. ' $K_{sac} = \frac{[1 - exp\ \mu d]}{\mu d}$ ' is the correction for the self-absorption of the γ-ray with the absorption coefficient μ for the target of thickness 'd'. Uncertainties (≤10%) included contributions from target thickness, detector efficiency, beam current, and counting statistics, for more details see the reference [3-5].

3. Results and Discussion

3.1 Systematic Model Calculations for Theranostic Isotopes [3]

We performed extensive TALYS and PACE-4 calculations for 14 alpha-induced reactions producing medically relevant isotopes. Fig. 2 illustrates the sensitivity to level density and optical potential.

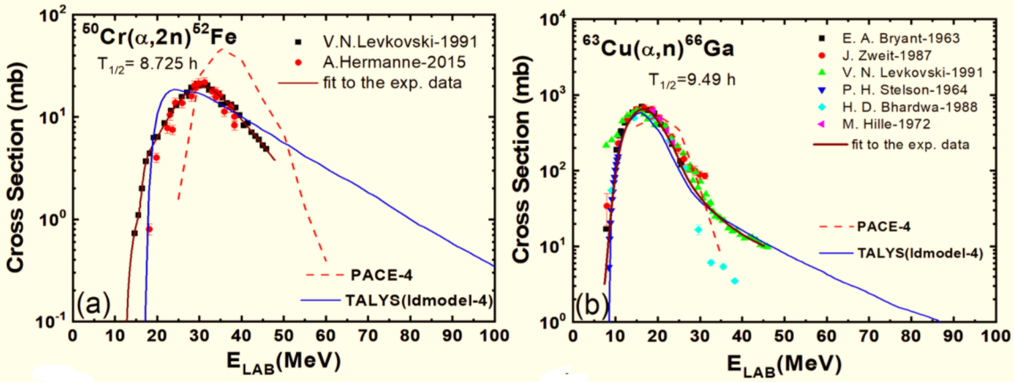

Fig. 2: Comparison of experimental and calculated excitation functions Excitation function for the radioisotope of medical relevance (a)^{50}Cr(α,2n)^{52}Fe, (b) ^{63}Cu(α, n)^{66}Ga[3].

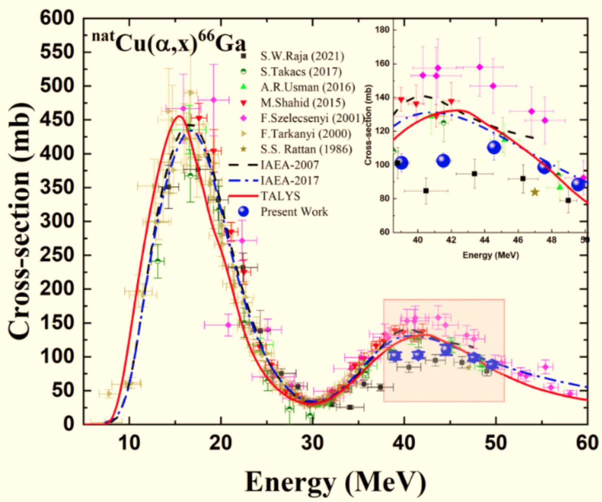

Fig. 3: Excitation function for ^{nat}Cu(α,x)^{66}Ga [4]. The present data (red circles) agree well with the IAEA recommended curve (solid line).

Key findings:

• Pre-equilibrium processes become dominant above 30 MeV; codes like PACE-4 that omit them underestimate cross sections.

• Level density models strongly influence results at higher energies, while α-OMP choice matters most near the Coulomb barrier.
• Thick target yields estimated from our data assist in production optimization.

3.2 Monitor Reactions on Natural Copper [4]

Excitation functions for $^{nat}Cu(\alpha,x)^{66,67}Ga$ and ^{65}Zn were measured in the 40–50MeV range, where prior data were sparse. Fig. 3 compares our results with IAEA recommended values and previous measurements. TALYS calculations using the α-OMP of Nolte et al. [6] and microscopic level densities from Skyrme-Hartree-Fock-Bogolyubov reproduced the experimental data excellently.

3.3 Excitation Functions on Natural Antimony [5]

Cross sections for $^{nat}Sb(\alpha,xn)^{121,123,124}I$ were measured at 40–50MeV, significantly improving the database above 40MeV. Figure-4 shows the results for ^{124}I. Optimal TALYS parameters included the Avrigeanu α-OMP [7], constant-temperature Fermi-gas level density, exciton pre-equilibrium model, and simplified modified Lorentzian γ-strength function.

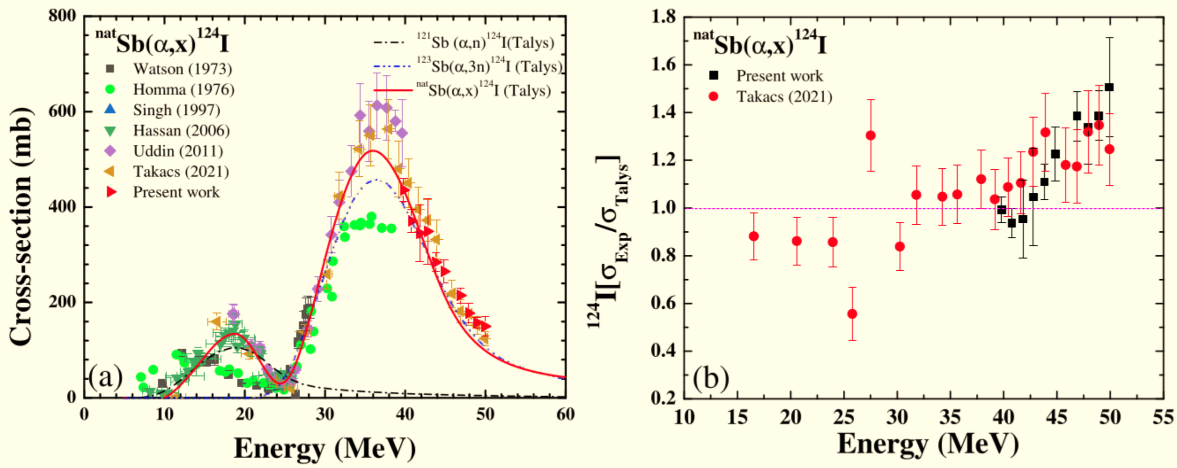

Fig. 4 Excitation function for $^{nat}Sb(\alpha,xn)^{124}I$[5]. The present data (red circles) are in excellent agreement with Takács et al. [8] and validate the optimized TALYS parameters (solid curve).

4. Conclusions

Our systematic investigation provides:

- Validated TALYS parameter sets applicable to a broad range of theranostic isotopes.

- Reliable cross-section data for alpha-induced reactions on natural Cu and Sb up to 50MeV.
- Clear evidence of the importance of pre-equilibrium mechanisms at higher energies.

These results contribute to the IAEA medical isotope database and support the development of improved production routes for diagnostic and therapeutic radionuclides.

5. Acknowledgments

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Studies on the fusion excitation functions and quasi-elastic scattering reactions around the Coulomb barrier

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Abstract

The study of fusion excitation function for ^{28}Si + ^{90,92,94}Zr and ^{94,100}Mo around the barrier is carried out to understand the deformation and multinucleon transfer channel effects. As detailed information was not found in the scope of many references [1–4] in the literature, a systematic and comprehensive study has been performed for all systems. Theoretical quasi-elastic excitation functions have also been studied for the systems ^{28}Si + ^{94,100}Mo, where the required optical model fitting parameters for the real part are used from the obtained fusion data. The observed results are consistent with expectations.

1. Introduction

Classically, nuclear fusion is assumed to occur only at energies above the Coulomb barrier, where the attractive and repulsive interactions balance. The quantum mechanical tunneling phenomena govern the fusion probabilities at energies near and below the Coulomb barrier, opening a door to study different phenomena, such as fusion enhancement and hindrance at sub-barrier regions. In heavy-ion fusion reactions, these sub-barrier effects are influenced by different degrees of freedom, like inelastic couplings, the static and dynamic deformations of participating nuclei, nucleon transfer channels, etc. The dominance of specific degrees of freedom in a given system requires thorough exploration.

Collectively, nuclear structures are classified as vibrational or rotational, depending on the energy spacing of their excited states. Their role in the fusion mechanism can be explored through a coupled-channel framework where spherical nuclei are represented with harmonic vibrations and deformed nuclei are modeled using a rigid rotor model. The coupling of the excited state and the ground state is measured using the transition probability $B(E\lambda)$, which is linked to the nuclear deformation parameter. The excitation energies and coupling constants for higher excited states are generally considered from the corresponding idealised coupling scheme. Furthermore, if all target nuclei exhibit similar coupling strengths, the experimental signature of transfer couplings will be more evident on comparison of all the systems.

The appropriate coupling scheme for ^{28}Si, whether vibrational or rotational in nature, is still not conclusively established [5]. For spherical and near-spherical target nuclei such as ^{120}Sn, ^{100}Mo, and ^{92}Zr [1,2,6–10], the fusion data have often been successfully described by incorporating rotational excitations. However, Newton et al. [2] reported that, in the case of the ^{92}Zr system, vibrational couplings provide a better explanation of the experimental observations. Since ^{28}Si exhibits both quadrupole and hexadecapole deformations [5], investigating its interaction with targets of different masses becomes particularly important. Therefore, ^{28}Si has been selected as the projectile to study reactions with the target nuclei ^{90,92,94}Zr and ^{94,100}Mo.

A significant enhancement of fusion cross-sections at sub-barrier energies has been experimentally observed in several systems possessing positive Q-value neutron transfer (PQNT) channels [1, 9, 11–16]. Besides the inclusion of projectile and target excitations, theoretical calculations that incorporate neutron transfer couplings often reproduce the experimental fusion data more successfully. Certain systems with favorable PQNT channels, such as ^{30}Si + ^{156}Gd [12], ^{18}O + ^{116}Sn [13], and ^{28}Si + ^{208}Pb [14], do not exhibit any noticeable enhancement in fusion cross-sections at sub-barrier energies. Therefore, the influence of PQNT channels on the fusion mechanism remains inconclusive, highlighting the need for further systematic experimental and theoretical investigations. In this context, the systems ^{28}Si + ^{90,92,94}Zr and ^{28}Si + ^{94,100}Mo have been investigated using coupled-channel calculations to examine the role of PQNT effects in these reactions.

Fusion measurements can be alternatively studied through quasi-elastic scattering at backward angles (e.g. 170˚ and 160˚) [15]. This method provides quasi-elastic excitation functions at large centre-of-mass angles without requiring separation of individual reaction channels such as elastic, inelastic, and transfer processes [17]. It also offers smaller statistical uncertainties compared to fusion measurements, especially above the Coulomb barrier. To examine the role of neutron transfer channels, coupled-channel calculations have been performed for ^{28}Si + ^{90,92,94}Zr and ^{28}Si + ^{94,100}Mo using fusion excitation data, and for ^{28}Si+^{94,100}Mo using quasi-elastic excitation functions. Since quasi-elastic and transfer data for these systems are presently unavailable, future experimental studies are planned.

2. Results and Discussion

Coupled-channel calculations have been performed for the measured fusion excitation function data using the CCFULL code [17]. Woods-Saxon parameters of the Akyuz-Winther (AW) potential are used to refine them to align the measured fusion excitation function data.

The deformation parameters were calculated from measured transition probabilities *B(E2)* [18] and *B(E3)* [19] using the expression

$$\beta_\lambda = \frac{4\pi}{3ZR^\lambda}\sqrt{\frac{B(E\lambda)\uparrow}{e^2}}$$

Here, $R (R = r_c A^{1/3})$ is the radius of the excited nucleus and r_c is taken to be 1.2 fm.

The coupled-channel calculations for the system ^{28}Si + $^{90,92,94}Zr$ have been done taking experimental fusion excitation data from reference [1, 2]. The fusion cross-sections calculated within a 1D-BPM framework are found to be underestimated as compared to the experimental values of all the systems.

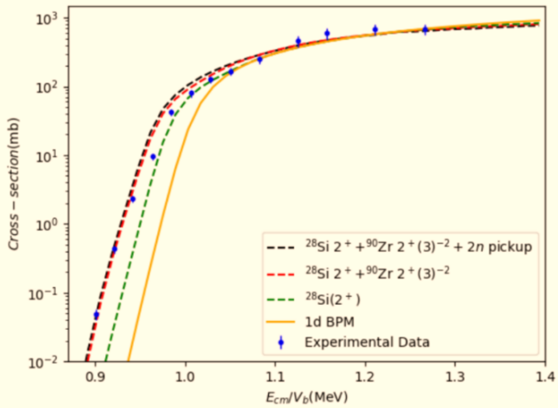

Fig. 1: Comparison of the fusion excitation function for the ^{28}Si + ^{90}Zr system, based on experimental data from reference [2] with new theoretical calculations using CCFULL.

In Figs. 1, 2, and 3, coupling to 2^+ and two phonons of the 3^- state of the target nuclei indicates better expansion in the fusion cross section, fitting the experimental data reasonably well. The system ^{28}Si + ^{90}Zr has a negative Q value for 2n transfer channels, so its influence on the sub-barrier fusion cross-section is seen to be negligible. In Fig. 2, the system ^{28}Si + ^{92}Zr has a positive Q value of 3.2541 MeV for the 2n transfer channel. Though it is a small rise, the addition of the 2n transfer channel along with the inelastic states gives better agreement with the experimental data.

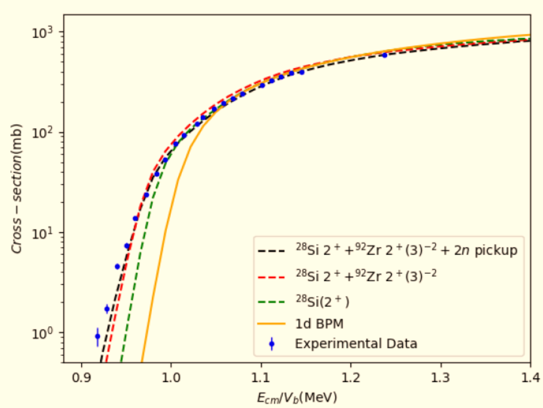

Fig. 2: Comparison of the fusion excitation function for the ^{28}Si + ^{92}Zr system, based on experimental data from Ref. [1] with new theoretical calculations using CCFULL

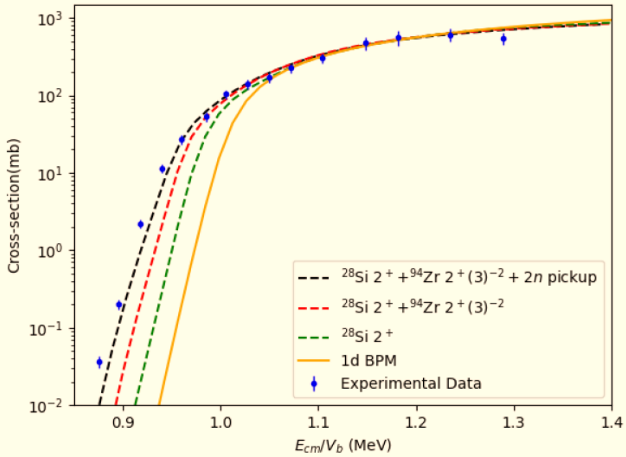

Fig 3: Comparison of the fusion excitation function for the ^{28}Si + ^{94}Zr system, based on experimental data from reference [2] with new theoretical calculations using CCFULL

In the system ^{28}Si + ^{94}Zr, the *Q* value for 2n transfer channels is 4.1289 MeV and positive. The enhancement due to the positive *Q* value in this system, along with inelastic states, better explains the measured data [2] as shown in Fig. 3. In the literature [1,2], the effect of 2n channels in the systems ^{28}Si + ^{90,92,94}Zr was mentioned, but it was not clearly shown for every channel in the plots. So, a revision study has been done for detailed information.

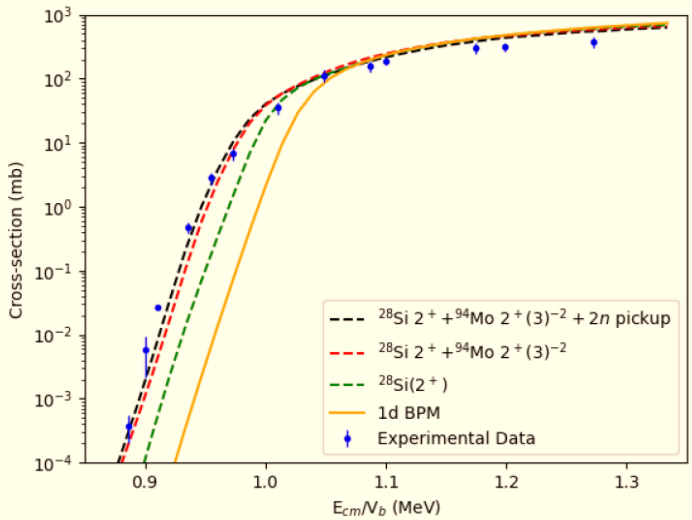

Fig 4: Comparison of the fusion excitation function for the ^{28}Si + ^{94}Mo system, based on experimental data from reference [3] with new theoretical calculations using CCFULL

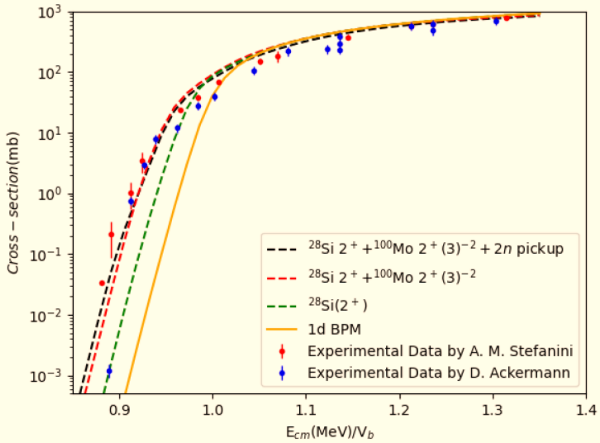

Fig 5: Comparison of the fusion excitation function for the ^{28}Si + ^{100}Mo system, based on experimental data from reference [3,4] with new theoretical calculations using CCFULL

Fusion excitation function has also being studied for both ^{28}Si + ^{94}Mo and ^{28}Si + ^{100}Mo systems taking experimental data from literature [3, 4]. Due to the lack of detailed information in the literature, a comprehensive study has been conducted for both systems. The effect of the positive Q value of the 2n transfer channel for the system ^{28}Si + ^{94}Mo is small but can be seen from Fig. 4. In Fig. 5, despite of having transfer channel with positive Q value, no enhancement is observed in the fusion cross-section. It can be expected that transfer channels other than 2n pickup may influence the enhancement. Due to the limitations of the CCFULL code, the dominance of transfer channels in this system is not clearly understood.

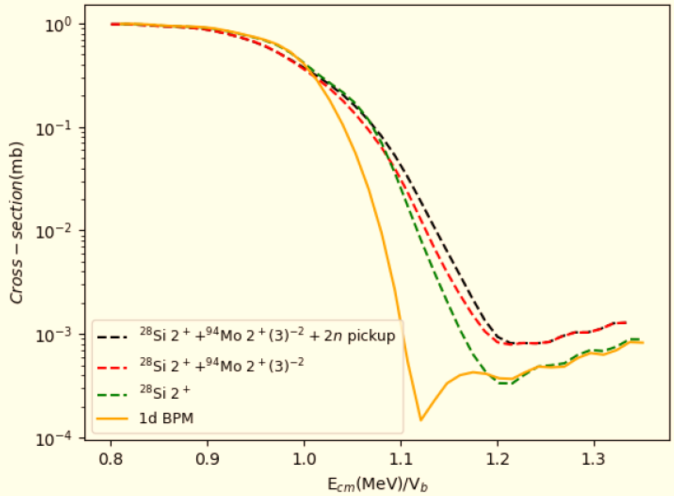

Fig 6: Quasi-elastic excitation function for ^{28}Si + ^{94}Mo with theoretical calculations using CCFULL

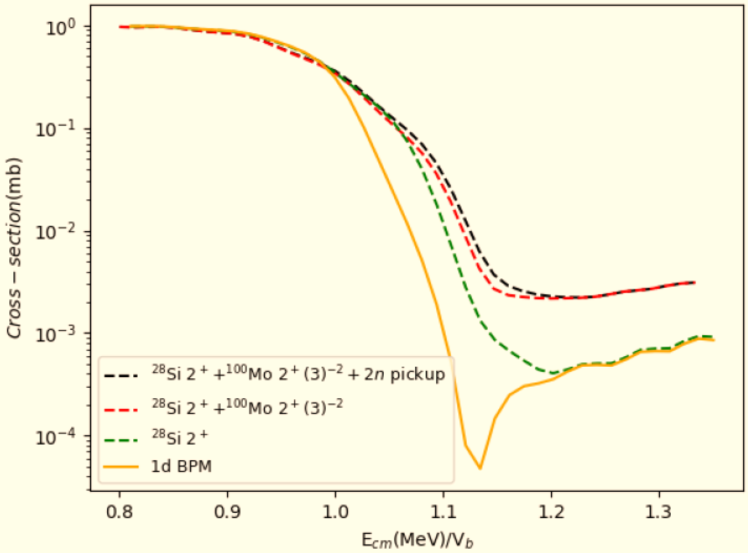

Fig 7: Quasi-elastic excitation function for ^{28}Si + ^{100}Mo with theoretical calculations using CCFULL

One of the important investigations has been performed on quasi-elastic scattering excitation functions for the systems ^{28}Si + ^{94,100}Mo for the first time. Due to the lack of experimental data, the same inelastic states, deformations and optical parameters have been considered as a reference fitted from the experimental data of fusion excitation function as reported in Fig. 4 and Fig. 5. As a result, a small enhancement in the quasi-elastic cross-sections is observed, including inelastic and PQNT channels which are shown in Fig. 6 and Fig. 7. Interestingly, there is an indication of the PQNT effect on ^{28}Si + ^{100}Mo system, which was not observed in the case of fusion data as shown in Fig. 5. Unlike for the ^{28}Si + ^{94}Mo system, the fusion, as well as quasi-elastic data, seems to be quite similar. Therefore, our theoretical investigation of the PQNT effect on ^{28}Si + ^{100}Mo would be a significant milestone for the scientific community.

3. Conclusion

Apart from deformation of the nuclei, transfer coupling also shows little effect in the fusion cross-section for ^{28}Si + ^{92}Zr but significant enhancement for ^{28}Si + ^{94}Zr and ^{28}Si + ^{94}Mo, indicating the role of positive *Q*-value neutron transfer. In contrast, no clear enhancement is observed for ^{28}Si + ^{100}Mo despite the presence of several positive *Q*-value channels, which may be due to the limitation of CCFULL in including only a pair of transfer channel. The new studies on quasi-elastic excitation functions have also been performed on ^{28}Si + ^{94,100}Mo systems. As a preliminary investigation, there is an enhancement of quasi-elastic excitation functions in both systems. However, since CCFULL allows inclusion of only one pair-transfer channel at a time, a comprehensive understanding requires coupled-channel calculations including all relevant transfer channels.

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Current Status of the Fermilab's Muon Anomalous Magnetic Moment Experiment

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Abstract

The Fermilab Muon g−2 collaboration has attained unprecedented precision in measuring the muon's anomalous magnetic moment (a_μ), reaching 0.20 parts per million (ppm). This represents a fourfold improvement in precision compared to earlier Brookhaven measurements. Our findings, when combined with previous results, yield a world average of $a_\mu(\text{exp}) = 116\,592\,059(22) \times 10^{-11}$, demonstrating a 5.0σ deviation from Standard Model predictions. This work details the experimental innovations enabling this breakthrough, particularly focusing on advanced laser calibration techniques and refined magnetic field characterization.

1. Introduction

The magnetic moment anomaly (a_μ) provides one of the most sensitive probes for physics beyond the Standard Model. Historical developments from Dirac's relativistic quantum mechanics to Schwinger's pioneering QED calculations established the theoretical framework for understanding g-factors. The muon's substantial mass makes its magnetic moment particularly responsive to potential new interactions. Building upon Brookhaven's 540 ppb measurement [2], which revealed a 3.7σ discrepancy, our Fermilab experiment [1] has achieved 0.20 ppm precision (Fig 1).

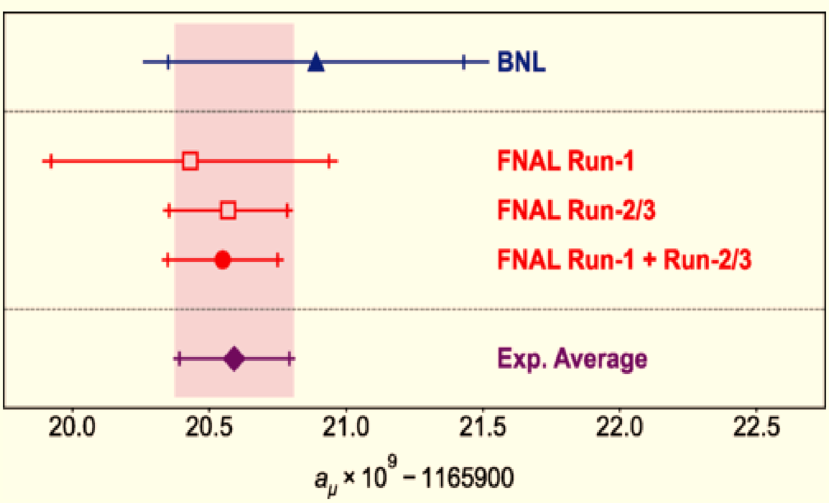

Fig 1: Comparison of a_μ determinations, including BNL's result [2], Fermilab's Run-1 data, our latest measurement, and the combined experimental average. Inner ticks indicate statistical uncertainty contributions.

2. Experimental Methodology

2.1 Storage Ring Dynamics

Our experiment utilizes a 14-meter diameter storage ring maintaining a 1.45 Tesla magnetic field [4]. Polarized muon bunches, injected at 11.4 Hz (about 10000 muons per fill), decay preferentially along their spin direction, producing higher energy positrons detected by 24 azimuthally arranged calorimeters. This spatial arrangement captures the modulation pattern resulting from spin precession (Fig. 2). Fig. 3 shows the storage ring of our lab.

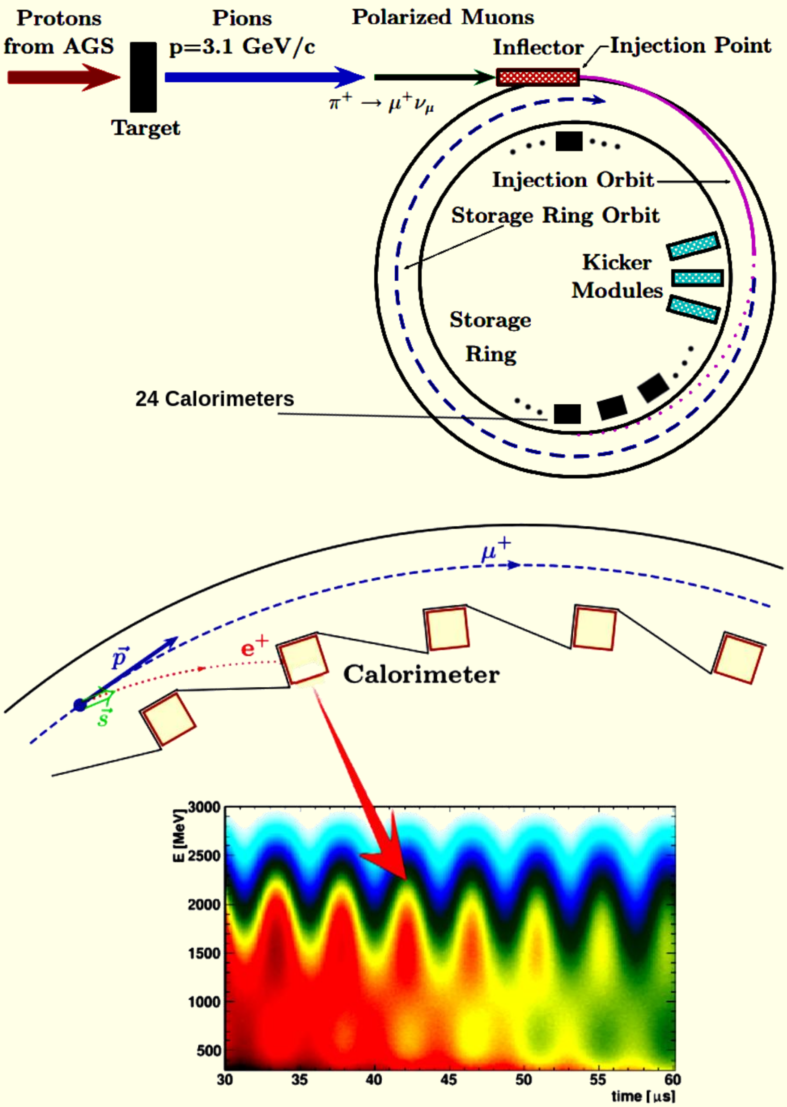

Fig 2: (above) Schematic representation of the Muon g−2 experiment and (below) when a positron is directed towards the interior of the ring, we see a peak, otherwise a trough.

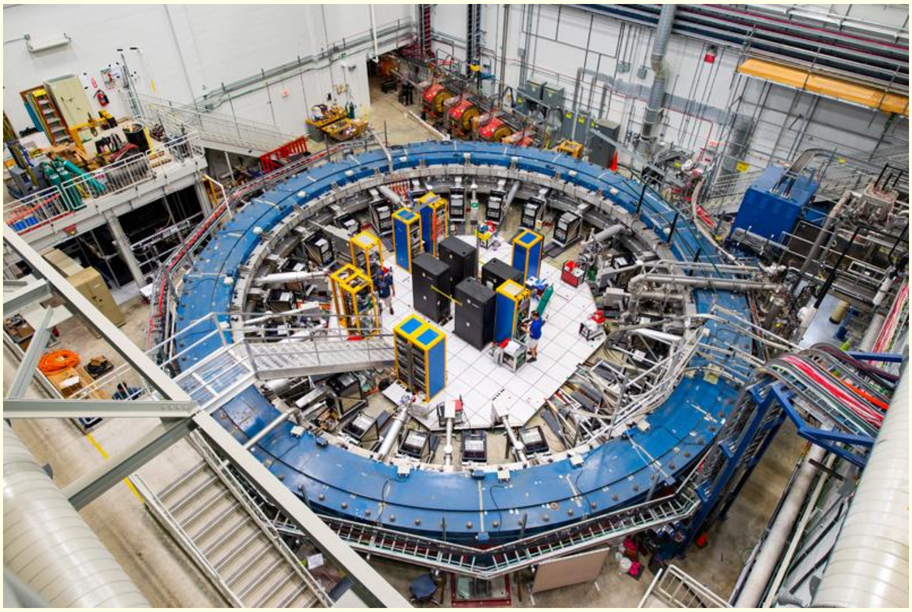

Fig. 3: Storage Ring of the laboratory

The anomalous precession frequency $\vec{\omega}_a$ relates to a_μ through:

$$\vec{\omega}_a = a_\mu \frac{e\vec{B}}{m_\mu} \quad (1)$$

Electric quadrupole focusing introduces an additional term:

$$\vec{\omega}_a = -\frac{e}{m_\mu}\left[a_\mu \vec{B} + \left(a_\mu - \frac{1}{\gamma^2-1}\right)\frac{\vec{\beta}\times\vec{E}}{c}\right] \quad (2)$$

By selecting muons at the "magic momentum" of 3.09 GeV/c, we nullify the electric field contribution, allowing cleaner extraction of ω_a from the positron decay spectrum:

$$f(t) = Ne^{-t/\tau_\mu}\left[1 + A\cos(\omega_a t + \phi)\right] \quad (3)$$

2.2 Analysis Techniques

The data were blinded by hiding the actual value of the calorimeter digitization clock frequency, and this blinding factor has been kept different for Run-2 and Run-3. Seven independent analysis groups applied their own (relative) software level blind offset in addition to the clock frequency blinding procedure in extracting ω_a^m through χ^2 minimization while fitting the function:

$$N(t) = N_0\eta_N(t)e^{-\frac{t}{\tau_\mu}}\left[1 + A\eta_A(t)\cos\left(\omega_a^m t + \phi_0 + \eta_\phi(t)\right)\right] \quad (4)$$

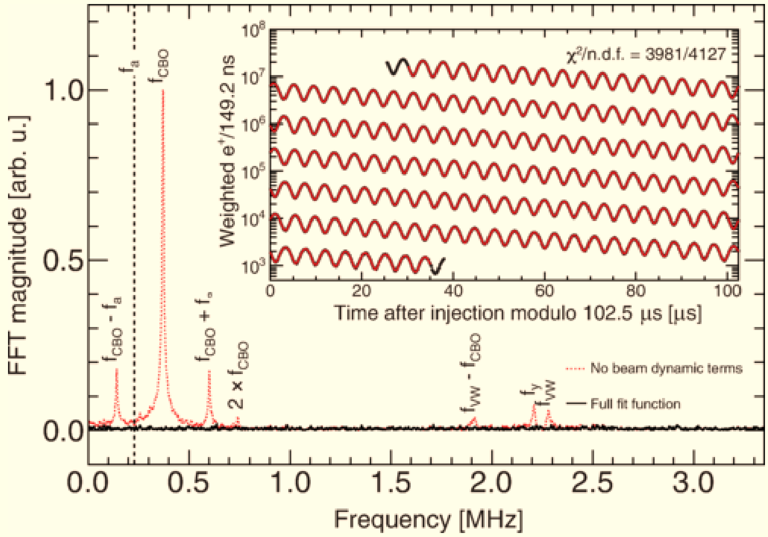

Fig. 4: Fit of Eq. (4)) to the Run-3a data, the details of the procedure can be found in our 2021 paper [3].

In Eq. (4) the function parameters include N_0 as the normalization constant, τ_μ representing the relativistic muon lifetime (approximately 64.4 μs), *'A'* as the mean weak-decay asymmetry parameter, and ϕ_0 denoting the initial phase offset between the muon's spin and momentum vectors. Time-varying correction terms η_N, η_A, and η_ϕ incorporate adjustments for transverse beam oscillations in both horizontal (x) and vertical (y) dimensions, accounting for coupled motion between these planes. Residual analysis (Fig. 4) confirmed the robustness of our fitting procedure [3].

2.3 Magnetic Field Characterization

The muon anomalous magnetic moment a_μ is determined from the frequency ratio:

$$a_\mu = \frac{\omega_a}{\omega_p}\frac{\mu_p}{\mu_e}\frac{m_\mu}{m_e}\frac{g_e}{2} \qquad (5)$$

Our experiment directly measures the frequency ratio ω_a/ω_p, where ω_a is extracted from fitting the precession signal while ω_p is determined using NMR probes. The remaining factors - the proton-to-electron magnetic moment ratio [5], muon-to-electron mass ratio [6, 7], and electron g-factor [9, 8] - are precisely known from independent measurements, contributing a combined uncertainty of approximately 25 ppb. Additional complexity arises from beam dynamics effects [3], E-field, pitch, and transient magnetic fields [4], which were carefully treated in the analysis.

3. Results and Discussion

Our measurements yield:

$$a_\mu \text{ (Run-1/2/3)} = 116\ 592\ 055\ (24) \times 10^{-11}\ (0.20\ \text{ppm})$$
$$a_\mu \text{ (World Average)} = 116\ 592\ 059\ (22) \times 10^{-11}\ (0.19\ \text{ppm})$$

They are also summarized in Fig. (1). The calculation of the muon g−2 involves contributions from all sectors of the Standard Model (SM). While the QED and electroweak components are well-established, the hadronic vacuum polarization (HVP) remains the dominant source of uncertainty. In 2020, the Muon g−2 Theory Initiative [10] provided a consensus SM prediction (wp20) with 0.37 ppm precision using a dispersive approach based on $e^+e^- \rightarrow hadrons$ data. However, a 2021 Lattice-QCD calculation [11] by the BMW collaboration reported a HVP value closer to the experimental measurement, differing by 2.1σ from wp20. Further tension arose in 2023 when the CMD-3 experiment's $\pi^+\pi^-$ cross-section data [12] disagreed with earlier results, reducing the discrepancy with the experimental a_μ.

4. Conclusions

The observed 5σ tension between experimental results and Standard Model expectations [10] underscores potential limitations in current theoretical frameworks. Additional data from Runs 4–6 (2020–2023), anticipated to halve statistical uncertainties by 2025, will refine the experimental precision to the target 140 ppb. Parallel advances in lattice QCD [11] and renewed scrutiny of $e^+e^- \rightarrow hadrons$ cross-sections may clarify persistent discrepancies in the hadronic sector. Future initiatives like the J-PARC E34 experiment (aiming for BNL-comparable precision) and novel approaches like the MUonE experiment at CERN could provide independent constraints on hadronic vacuum polarization, further testing the Standard Model's boundaries.

5. Acknowledgements

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Unlocking the Secrets of Nuclear Fission: How Multi-Chance Fission Drives Asymmetry

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1. Description

Fission reactions initiated by heavy ions, particularly in the vicinity of the actinide region, play a crucial role in the formation of superheavy nuclei (SHN) [1]. These phenomena are predominantly influenced by factors such as mass asymmetry (α) [2], the Businaro-Gallone critical mass asymmetry factor (α_{BG}) [3], the Coulomb parameter ($Z_P Z_T$), etc. The fusion-fission (FF) process, which occurs through an intermediate state, tends to have a longer duration compared to the rapid quasi-fission (QF) process, which involves the formation of a dinuclear system [4]. Also, the number of emissions of pre-neutrons and post-neutrons is influenced by their dynamics [5].

Fission dynamics remains a highly complex and intriguing field, particularly regarding the interplay of factors that dictate fission fragment mass distributions (FFMD). At relatively low excitation energies (typically up to ≈ 40 MeV), microscopic shell effects are strongly pronounced, predominantly steering the nucleus toward asymmetric mass distributions. Traditional frameworks, such as the macroscopic liquid drop model (LDM), predict that as the excitation energy of the compound nucleus (E*) increases, these shell effects should systematically wash out, resulting in purely symmetric fission [6,7]. However, recent experimental and theoretical investigations have frequently observed the persistence of asymmetric fission modes even at excitation energies well above this 40 MeV threshold. This anomalous behaviour is fundamentally linked to the concept of multi-chance fission (MCF).

In our recent study published in the *Indian Journal of Physics*, we addressed this phenomenon by systematically investigating the heavy-ion induced fission of ^{238}U, ^{237}U, and ^{228}U [8]. Utilizing the semi-empirical GEF (GEneral description of Fission observables) code [9], we modelled the fission process to explicitly account for neutron evaporation and nuclear deformation effects prior to scission. In high-energy fission, a highly excited compound nucleus possesses sufficient thermal energy to emit one or multiple pre-scission neutrons (ν_{pre}) before the system fragments. Each successive neutron evaporation incrementally reduces the effective excitation energy (E_{eff}^*) of the residual nucleus as shown in Fig. 1.

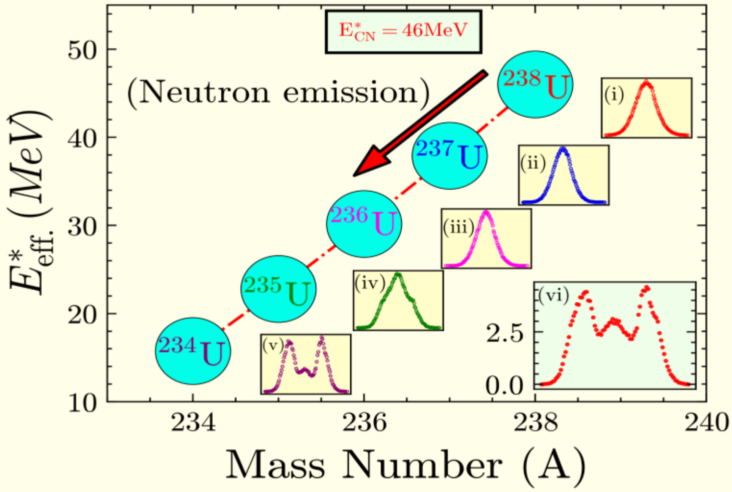

Fig. 1: A theoretical perspective on MCF of ^{238}U at E=46 MeV, including different chance fissions. First chance fission mass distributions are shown in Insets: (i) ^{238}U, (ii) ^{237}U, (iii) ^{236}U, (iv) ^{235}U, (v) ^{234}U, and in inset (vi) the FFMD of ^{238}U at an excitation of 46 MeV.*

The theoretical analysis of the ^{238}U system at an initial E* = 46 MeV perfectly illustrates this dynamic. While the initial compound nucleus is highly excited, the pre-neutron multiplicity is calculated to be $\nu_{pre} \approx 4$ as shown in Fig. 2. The sequential emission of these pre-fission neutrons lowers the E_{eff}^* significantly, allowing structural shell effects to robustly re-emerge. The study demonstrates that the observed asymmetric FFMD for the ^{238}U system is not driven by the first-chance fission (FCF) of the initial compound nucleus, but rather by the dominant MCF events occurring in the cooler daughter nuclei, specifically ^{235}U (at E_{eff}^* = 22.79 MeV) and ^{234}U (at E_{eff}^* = 15.75 MeV). A similar mechanism governs the asymmetric distribution of ^{237}U at 30 MeV, where $\nu_{pre} \approx 2$, and the second and third chances of fission predominantly contribute to the fragment asymmetry.

In striking contrast, the neutron-deficient ^{228}U system exhibits uniquely different fission characteristics. Evaluated at an identical initial excitation energy of 46 MeV, the FFMD for ^{228}U displays a distinctly symmetric pattern, completely devoid of the shoulder-like structures indicative of shell-stabilized asymmetric splits as shown in Fig. 3. We attribute this variance to the much higher neutron separation energy of ^{228}U (approximately 7.87 MeV, compared to 6.15 MeV for ^{238}U). This higher separation threshold severely restricts pre-neutron emission, capping ν_{pre} at roughly 1 to 2. Consequently, the fission process is heavily dominated by the first-chance fission of the initial ^{228}U nucleus before the system can sufficiently "cool" via neutron evaporation. Because the E_{eff}^* remains elevated at the scission point, shell effects cannot re-assert themselves, inevitably leading to a symmetric mass split.

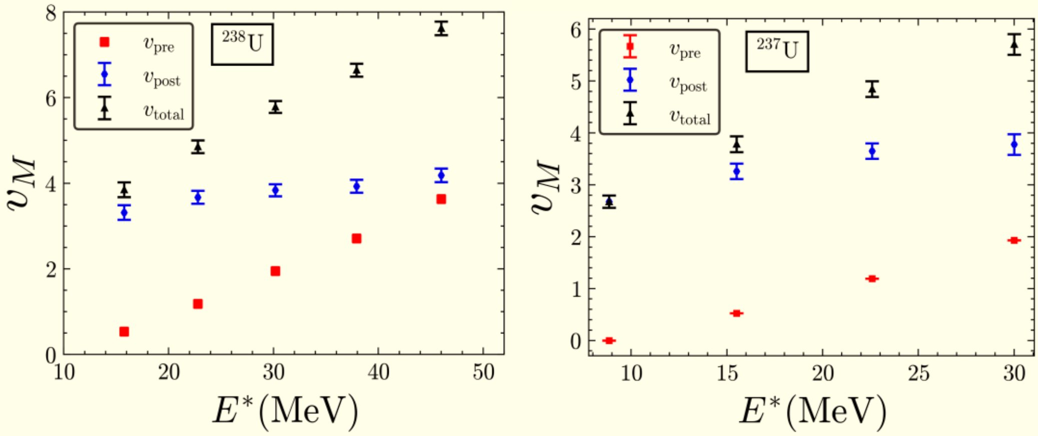

Fig. 2: Pre-scission (v_{pre}), Post-scission (v_{post}), and Total (v_{total}) neutron multiplicity calculated for ^{238}U and ^{237}U in the range of E =10–50 MeV using the GEF [9]. At an excitation energy of 46 MeV, the uncertainties in v_{post} = 0.1581, v_{total} = 0.158. The uncertainties for v_{pre} are not explicitly shown, as their values are extremely small reaching within the symbol, of the order of 10^{-9}.*

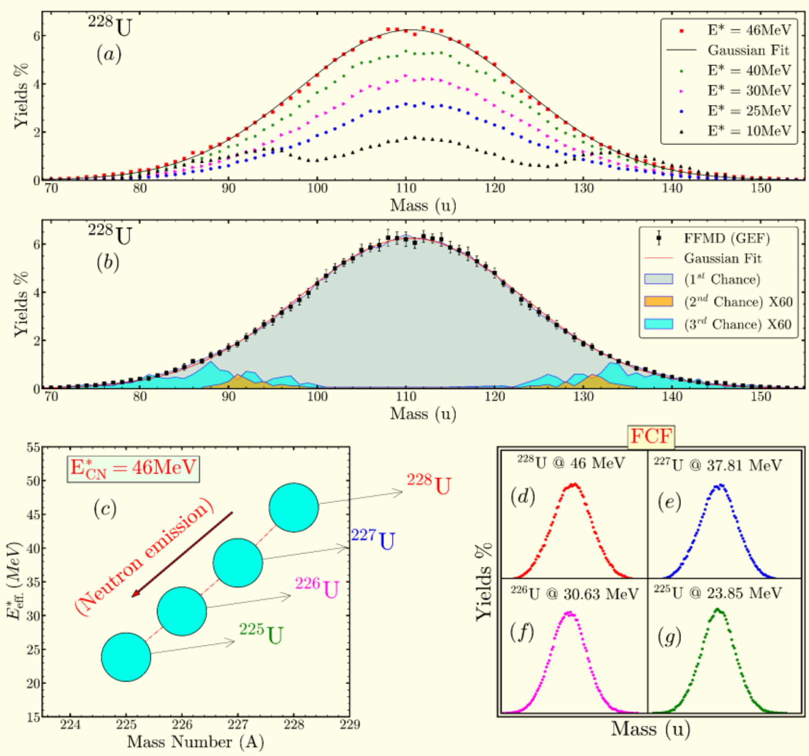

Fig. 3: FFMD of ^{228}U at different excitation energies and FFMD with multi-chance fission of 46 MeV (subplots (a) and (b)). And a theoretical perspective on MCF of ^{228}U at E=46 MeV (subplot (c)). First-chance fission mass distributions are shown in subplots: (d) ^{228}U, (e) ^{227}U, (f) ^{226}U, and (g) ^{225}U.*

Further supporting these conclusions, we analyzed the two-dimensional correlations between fragment mass and total kinetic energy (Mass-TKE). The spectra clearly display the progression from symmetric to asymmetric distributions as E_{eff}^* decreases across the successive fission chances. Furthermore, in the paper, the study modeled mass-dependent average prompt-neutron multiplicity, revealing a characteristic "sawtooth" pattern at lower excitation energies [8]. As expected, this damping effect is particularly pronounced near double-magic closed shell configurations (such as Z=50 and N=82, corresponding to the ^{132}Sn region) and gradually diminishes as initial excitation energy rises.

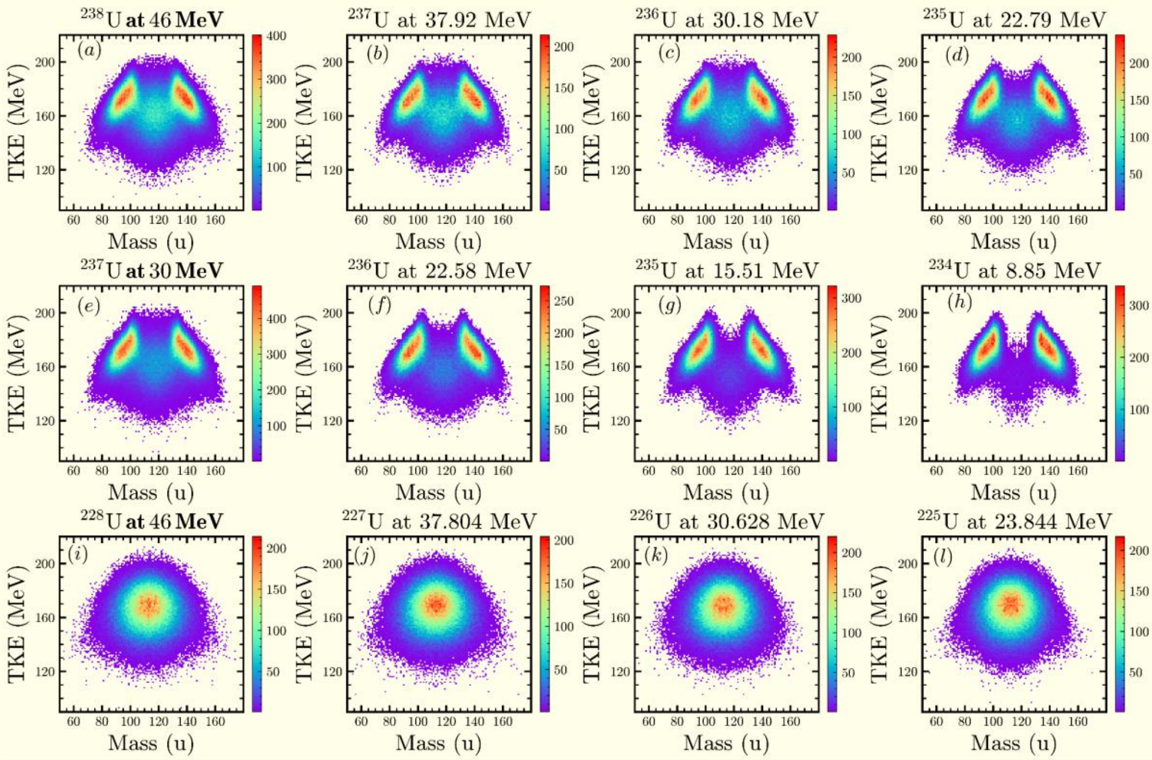

Fig. 4: GEF [9] generated two-dimensional spectrum of fission mass vs TKE at several excitation energies (E), showing both projectile-like and target-like particles along with fission events for the first two isotopes where an asymmetric pattern is seen at low E* (a-h). In the lower panel, no shoulder-like structure but symmetric patterns are observed for all E* (i-l).*

Ultimately, this work underscores that asymmetric FFMDs observed at elevated energies are primarily an artifact of multi-chance fission, governed heavily by the FCF of subsequent daughter nuclei. By clarifying the interplay between initial excitation energy, neutron separation energy, and pre-neutron multiplicity, the study provides a robust framework for predicting the survival and dissolution of shell effects. These systematic insights are highly relevant for advancing fundamental nuclear reaction modelling, optimizing Accelerator-Driven Systems (ADS) for nuclear transmutation, and refining the theoretical pathways required for synthesizing superheavy nuclei (SHN).

2. Acknowledgements

The authors express sincere gratitude to the Department of Physics of Gauhati University and the Physics Department of Rangia College for their invaluable support and contributions.

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A Century of Quantum Mechanics: From Theory to Transformative Technologies

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Abstract

The transition from classical to quantum physics marks a revolutionary shift in the understanding of the fundamental nature of reality. Classical mechanics governed by Newtonian laws successfully explains macroscopic phenomena but fails at atomic and subatomic scales. The emergence of quantum mechanics introduced concepts such as wave-particle duality, superposition and entanglement redefining the behaviour of matter and energy. Quantum theory not only resolved limitations of classical physics but also paved the way for groundbreaking advancements in quantum computing, cryptography and sensing technologies. The uncertainty principle and quantum tunnelling further highlight the probabilistic nature of quantum systems that contrasting with the determinism of classical mechanics. This journey from classical determinism to quantum probability has transformed scientific thought that leading to practical applications and shape the modern technology. As the research continues on the development of quantum science, theories promises deeper insights into the universe that unlocking new technological frontiers.

1. Introduction

Quantum mechanics is one of the most profound and revolutionary theories in the history of science [1]. It has transformed our understanding of nature at its most fundamental level that shaping modern physics, chemistry and even biology in the past century. From the early theoretical developments in the 1900s to cutting-edge applications in computing, communication and sensing, quantum mechanics has evolved into a basis of technological progression [2].

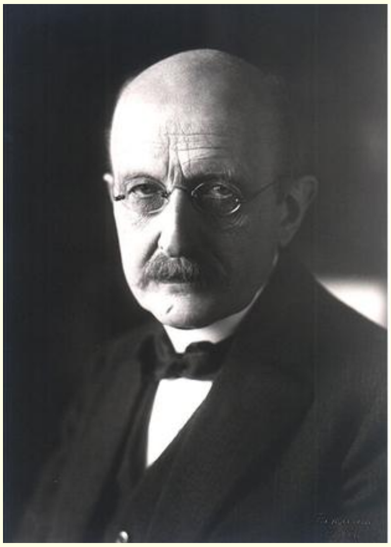

Fig 1: Max Planck

The journey of quantum mechanics began in the early 20th century when classical physics failed to explain phenomena such as blackbody radiation and the photoelectric effect. Max Planck's introduction of energy quantization in 1900 marked the birth of quantum theory and thus Planck is also called "Father of Quantum Mechanics". Thereafter Albert Einstein's explanation of the photoelectric effect in the 1905 further improved the theory of quantum mechanics which proposed that light consists of discrete particles called "Photons". These revolutionary ideas laid the foundation for a series of groundbreaking discoveries that would challenge classical notions of determinism and continuity.

In the 1920s and 1930s, the development of quantum mechanics accelerated with the contributions of Niels Bohr, Werner Heisenberg, and Erwin Schrödinger. Bohr's atomic model introduced quantized energy levels while Heisenberg's uncertainty principle and Schrödinger's wave mechanics provided a mathematical framework for describing quantum systems. These ideas culminated in what is now known as the first quantum revolution which not only explained atomic and subatomic behaviour but also led to the development of semiconductors, lasers and nuclear energy.

As quantum mechanics already established, the experimental confirmations strengthened its trustworthiness. The double-slit experiment, electron diffraction studies and Bell's theorem tests provided direct evidence of wave-particle duality, superposition, and quantum entanglement. Quantum mechanics soon became essential in explaining chemical bonding, superconductivity and many other physical properties.

The second half of the 20th century witnessed the emergence of the second quantum revolution, which focused on harnessing quantum properties for practical applications. Quantum cryptography, quantum computing and quantum teleportation became areas of intense research. All these are promising to revolutionize information technology and communication. Superconducting qubits, trapped ions and photonic quantum circuits opened new pathways toward scalable quantum computers that could outperform classical machines in solving complex problems.

Today quantum mechanics is at the heart of cutting-edge research and innovation. Technologies such as quantum sensors, infrared detectors and superconducting circuits have practical applications in medicine, navigation and space exploration. As we enter the next century of quantum exploration, the field continues to expand and offer unprecedented possibilities from unlocking the mysteries of quantum gravity to developing fault-tolerant quantum computers. The future of quantum mechanics is filled with exciting prospects that could redefine science and technology as we know them. By understanding the journey of quantum mechanics over the last 100 years, we gain insight into one of the most influential scientific revolutions in human history.

2. Early developments

The roots of quantum mechanics trace back to the early 1900s when classical physics failed to explain certain phenomena. Here a brief discussion of some major steps that were engaged for the development of quantum mechanics is given below:

2.1 The quantum hypothesis

Max Planck's quantum hypothesis was revolutionary as it proposed that energy is not continuous but rather quantized. He introduced the concept of energy quanta with his famous equation:

$$E = h\nu,$$

where E is the energy of a quantum, h is Planck's constant (approximately 6.626×10^{-34} J·s), and v is the frequency of the radiation. This resolved the ultraviolet catastrophe, which was a major problem in classical physics.

2.2 Einstein's photoelectric effect (1905)

Einstein extended Planck's idea by proposing that light consists of discrete energy packets called "Photon" and each photon carrying energy proportional to its frequency.

This discovery explained why electrons are emitted from a metal surface only when the incident light has a frequency above a certain threshold frequency. This solved the problem raised in classical wave theory. His work led to the development of quantum optics and won him the nobel prize in physics in 1921.

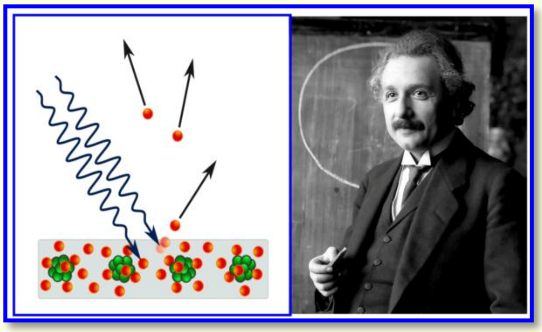

Fig 2: Photo electric effect and Einstein in 1921

2.3 Bohr's atomic model (1913)

Niels Bohr further advanced quantum theory by introducing a model of the hydrogen atom that incorporated quantized energy levels for electrons. His postulates included:

a) Electrons orbit the nucleus in discrete energy levels.

b) Energy is absorbed or emitted when an electron transitions between levels.

c) The angular momentum of an electron is quantized.

Bohr's model successfully explained spectral lines of hydrogen but had limitations for more complex atoms.

2.4 Wave-particle duality

Louis de Broglie (1924) proposed that particles like electrons exhibit both wave and particle characteristics and the famous de Broglie wavelength λ can be expressed as:

$$\lambda = h/p$$

Where λ is the wavelength, h is Planck's constant and p is momentum of the particle.

This idea was later confirmed by The Davisson-Germer experiment in 1927. This experiment showing that matter can exhibit both particle and wave properties.

2.5 Heisenberg's uncertainty principle (1927)

Werner Heisenberg formulated the uncertainty principle which stating that, it is impossible to simultaneously measure the exact position and momentum of a particle. This introduced fundamental limits in the measurement in quantum systems. Heisenberg's uncertainty principle can be written as:

$$\Delta x \times \Delta p \geq h/4\pi$$

Where Δx is uncertainty in position, Δp is uncertainty in momentum and h is the Planck's constant. This principle challenges classical physics that highlighting the intrinsic probabilistic nature of quantum systems. It has profound implications in fields like semiconductor physics, quantum cryptography and electron microscopy. The principle also explains atomic stability and the behaviour of subatomic particles. This influence the modern technological advancements and deepening our understanding of the fundamental nature of reality.

2.6 Schrödinger's wave equation (1926)

Erwin Schrödinger developed the wave equation that describes the evolution of quantum states:

$$i\hbar \frac{\partial \psi(r,t)}{\partial t} = \boldsymbol{H}\psi(r,t)$$

where i is the imaginary unit, $\hbar$ is the reduced Planck's constant, ψ(r, t) is the wave function, ***H*** is the Hamiltonian operator, r represents position and t is time.

This equation provides a mathematical framework to determine the probability distribution of a particle's position and momentum. The equation explains atomic and molecular structures that enabling advancements in the fields like semiconductors, nanotechnology and quantum computing. It bridges the gap between classical and quantum physics that offering insights into wave-particle duality, tunnelling and energy quantization. This important equation is an essential part for the development of modern physics and technological innovations.

3. Experimental evidence of hypothesis and theories

Theoretical developments in quantum mechanics were soon confirmed through experimental verification. Here a number of important experiments related to the establishment of quantum mechanical theories have been demonstrated as below:

3.1 The Young's double-slit experiment:

This experiment originally performed by Thomas Young in 1801 and later adapted to quantum mechanics. This experiment demonstrated that electrons and photons exhibit wave-particle duality.

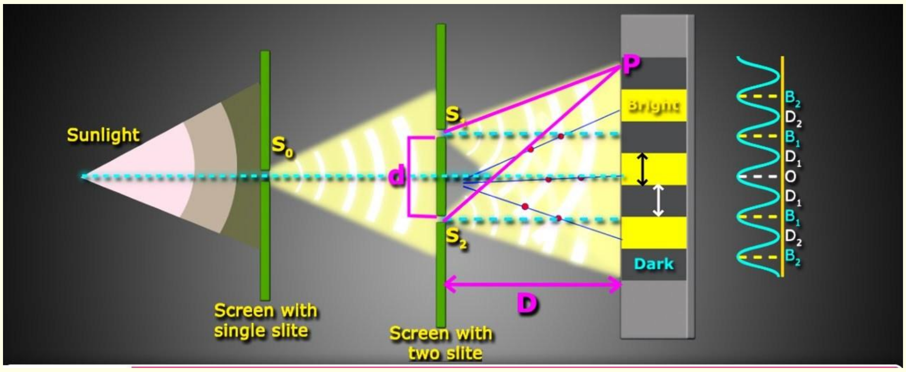

Fig 3: Young's double slit experiment

It provided crucial evidence against Newton's particle theory of light and laid the foundation for wave optics. Later its implications extended to quantum mechanics, enlightening wave-particle duality when performed with electrons and other particles. This experiment challenges classical intuition and emphasizing the probabilistic nature of quantum mechanics that making it one of the most profound demonstrations of fundamental physics principles.

3.2 Stern-Gerlach experiment (1922)

Otto Stern and Walther Gerlach in 1922 performed the experiment that demonstrating the quantization of angular momentum and the existence of electron spin. The experiment showed discrete deflections of a beam of silver atoms when passing through a non-uniform magnetic field. This contradicts the classical expectations and confirming space quantization. This provided direct evidence that particles possess intrinsic angular momentum (spin) with only specific orientations. It laid the foundation for quantum state measurement, spintronics and quantum computing. Moreover this experiment played a crucial role in developing quantum mechanics that influencing the formulation of the Pauli exclusion principle and advancements in atomic and particle physics.

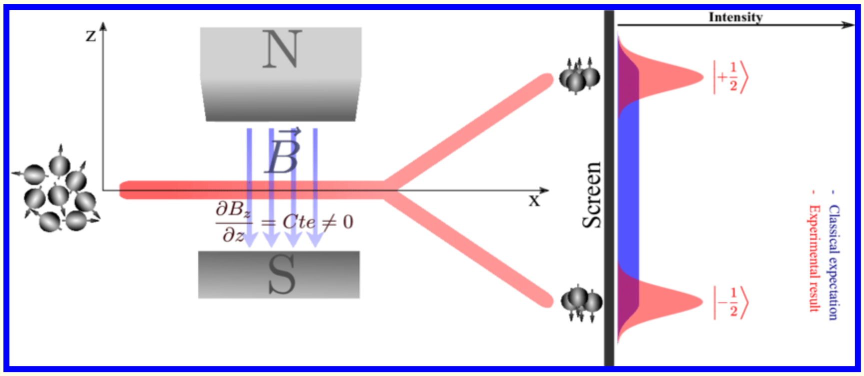

Fig 4: Sketch of Stern-Gerlach Experiment [3]

3.3 The Davisson-Germer experiment (1927)

Clinton Davisson and Lester Germer in 1927 confirmed de Broglie's hypothesis by showing that electrons produce diffraction patterns when scattered off a crystal. This experiment confirmed the wave nature of electrons that supporting de Broglie's hypothesis of matter waves. This experiment validated Schrödinger's wave equation and paved the way for electron microscopy and modern quantum technologies. It also reinforced the principle that all particles exhibit both wave and particle characteristics and fundamentally shaping our understanding of atomic and subatomic physics.

3.4 Bell's theorem and quantum entanglement (1964)

Quantum entanglement is a phenomenon where two or more particles become correlated in such a way that the state of one instantly influences the state of the other regardless of their distance. This non-local connection has been experimentally confirmed through tests using entangled photons, electrons and other quantum systems.

In 1964, John Bell proposed a test to distinguish quantum mechanics from local hidden variable theories. Bell's Theorem is a fundamental result in quantum mechanics that challenges classical notions of locality and realism. It states that no local hidden variable theory can fully explain the correlations predicted by quantum mechanics for entangled particles. Bell's Theorem and entanglement play a crucial role in quantum computing, cryptography and fundamental physics that reinforcing the non-classical nature of quantum mechanics.

3.5 Quantum Hall effect: Precision meets topology

Klaus von Klitzing's 1980 discovery of the integer quantum Hall effect revealed quantized resistance in 2D electron systems under strong magnetic fields. This led to a new resistance standard and insights into topological phases of matter. It is a quantum phenomenon observed in two-dimensional electron systems cooled to near absolute zero and exposed to strong magnetic fields. It manifests as the quantization of the Hall resistance into precisely defined plateaus at values of R_H given by-

$$R_H = \frac{h}{\nu e^2}$$

where *h* is Planck's constant, *e* is the electron charge, and *v* (the "filling factor") is an integer (Integer QHE) or fraction (Fractional QHE). The Integer QHE arises from the formation of Landau energy levels and localized electron states due to disorder, while the Fractional QHE discovered in 1982 involves collective electron interactions forming quasiparticles with fractional charges. This explained via Laughlin's theory and composite fermion models. The Integer QHE earned von Klitzing the 1985 Nobel Prize, while the Fractional QHE led to the 1998 Nobel for Tsui, Störmer and Laughlin. The QHE remains pivotal in understanding strongly correlated quantum systems and topological phases. It bridging condensed matter physics and fundamental quantum theory.

4. The first quantum revolution: From labs to society (1940s–1990s)

4.1 Transistors and the semiconductor revolution

John Bardeen, Walter Brattain and William Shockley invented the transistor in 1947 leveraging quantum tunneling and band theory. Transistors replaced vacuum tubes that are enabling microelectronics and the digital age. Moore's Law (1965) predicted exponential growth in computing power that's driven by quantum-engineered silicon chips.

4.2 Lasers: Coherent light for modern life

The first laser built by Theodore Maiman in 1960 originated from stimulated emission, which is a quantum process predicted by Einstein. Applications of laser span fiber-optic communication, barcode scanners and medical surgeries.

4.3 MRI: Quantum spin in medicine

Nuclear Magnetic Resonance (NMR) discovered by Felix Bloch and Edward Purcell (1946) by using quantum spin interactions to image tissues. This non-invasive tool refined into MRI scanners in the 1970's that revolutionized diagnostics.

4.4 Atomic clocks: Timekeeping at quantum precision

Atomic clocks developed in the 1950's measure time via microwave transitions in cesium atoms. They underpin GPS satellites that ensuring nanosecond accuracy for global navigation.

5. The second quantum revolution: Harnessing quantum weirdness (1990s–Present)

5.1 Quantum computing: Beyond classical limits

Quantum computing is a revolutionary field of computing that leverages the principles of quantum mechanics to process information in such a number of ways that classical computers cannot do. Unlike traditional computers that use bits (which represent either 0 or 1), quantum computers use "Qubits" (quantum bits), which can exist in superposition (both 0 and 1 simultaneously). This allows them to perform multiple calculations at once, vastly increasing computational power.

Milestones:

a. 1994: Peter Shor's algorithm for factoring large numbers threatened classical encryption.

b. 2019: Google's Sycamore demonstrated quantum supremacy by solving a problem in just 200 seconds, whereas a supercomputer would take 10,000 years.

c. 2023: IBM's 433-qubit osprey and modular quantum systems pave the way for error-corrected machines.

5.2 Quantum cryptography: Unhackable communication

a. BB84 Protocol: Idea proposed by Charles Bennett and Gilles Brassard (1984) and uses photon polarization to exchange keys.

b. Quantum Key Distribution (QKD): Networks in China, Switzerland and the U.S. use entangled photons to secure government and financial data.

5.3 Quantum sensing: Measuring the invisible

a. Gravitational Wave Detection: Quantum squeezing developed LIGO's interferometers detected ripples in spacetime from colliding black holes.

b. Medical Imaging: Diamond-based sensors with nitrogen-vacancy (NV) centers map neural activity and detect tumors at early stages.

6. Recent frontiers: Quantum mechanics in the 21st century

6.1 Quantum entanglement: Spooky action at a distance

a. Quantum Networks: China's Micius satellite (2017) teleported entangled photons over 1,200 km. This makes a significance step toward a global quantum internet.

b. Entanglement Swapping: Long distance quantum communication can be enabling by linking distant qubits via intermediaries.

6.2 Energy teleportation: A new paradigm?

Researchers in 2022 demonstrated energy teleportation in quantum circuits inspired by Masahiro Hotta's theoretical work. This could revolutionize energy distribution in quantum systems without violating thermodynamics.

6.3 Quantum machine learning

a. Hybrid algorithms: Google's tensor flow quantum combines classical and quantum processing to optimize logistics and drug design.

b. Quantum Neural Networks (QNN): Leveraging superposition to process vast datasets exponentially faster.

6.4 Quantum resistance standards

With the help of nanotechnology and metrology the graphene-based devices using the quantum Hall effect redefine the ohm with atomic precision.

6.5 Infrared quantum detectors

Single-photon detectors with superconducting nanowires enhance astronomy, night vision and environmental monitoring.

6.6 Attosecond Lasers: Capturing electron motion

Nobel laureate Anne L'Huillier's work on attosecond pulses allows real-time observation of electron dynamics that advancing photochemistry and material science.

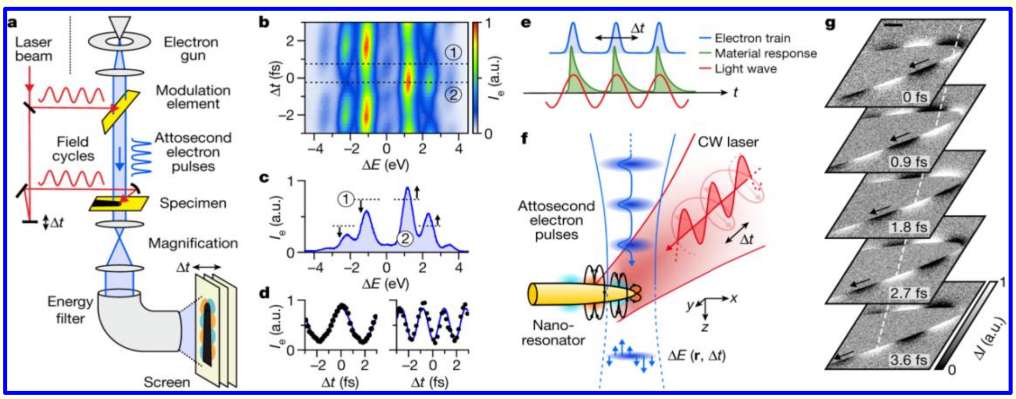

Fig 5: Attosecond electron microscopy [4]

6.7 Superconducting Qubits

a. Transmon Qubits: Coherence times of these qubits exceeding 100 microseconds make them ideal for quantum processors.

b. Topological Qubits: Microsoft's pursuit of fault-tolerant qubits using Majorana fermions.

7. Quantum for good: Solving global challenges

7.1 Healthcare

Quantum mechanics revolutionizes healthcare through quantum computing for drug discovery, quantum sensing for precise imaging (MRI, PET) and quantum cryptography for secure medical data. Quantum dots enhance bio-imaging while quantum-inspired algorithms improve diagnostics and personalized medicine. These advancements enable faster more accurate disease detection, treatment and patient care.

7.2 Climate and Energy

Quantum mechanics revolutionizes the climate and energy sector by enabling high-efficiency solar cells, quantum batteries and superconductors that reduce energy loss. Quantum computing accelerates climate modelling and material discovery for carbon capture. Quantum sensors enhance weather forecasting and environmental monitoring that aiding sustainable energy solutions and climate change mitigation.

7.3 Secure Communication

Quantum Key Distribution (QKD) uses quantum properties like superposition and entanglement to ensure encryption keys remain secure. Any eavesdropping attempt disturbs the quantum states and alerting users. This principle makes QKD-based communication virtually unbreakable that ensuring high-level security for military, financial and governmental data.

7.4 Agriculture

Quantum mechanics enhances agriculture through precision sensing, improving soil and crop monitoring via quantum sensors. Quantum computing optimizes resource management, predicting weather patterns and pest control. Quantum dots improve photosynthesis efficiency that boosting crop yields.

8. Conclusion: The quantum century and beyond

The past century has seen quantum mechanics evolve from the Planck’s hesitant quanta to google’s quantum supremacy. The challenge lies in harnessing its power responsibly as we have already entered the second quantum revolution. With global collaboration and ethical foresight, quantum technologies could solve crises from climate change to disease, ushering in an era of unprecedented human progress. The next 100 years promise not just to deepen our understanding of reality but to redefine it.

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Naked in the Cosmos: JWST's Discovery of a Supermassive Black Hole Without Its Galaxy

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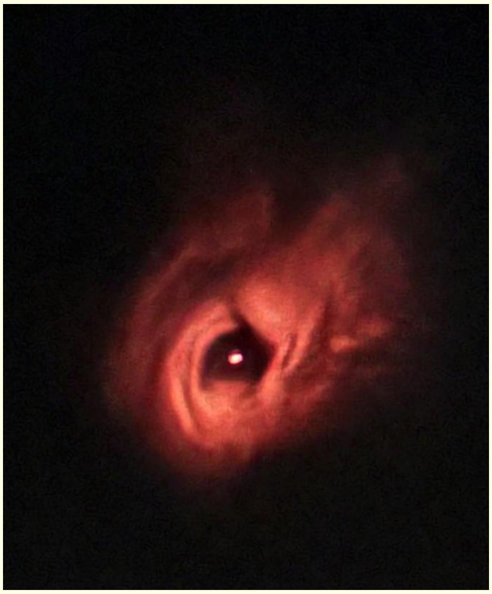
1. Introduction

The James Webb Space Telescope (JWST) has revealed a remarkable supermassive black hole in the distant, early universe one so isolated that researchers describe it as nearly naked. Designated as Abell 2744-QSO1 (often shortened to QSO1), and part of the class of objects known as Little Red Dots (LRDs) at a redshift of $z \approx 7.04$, this finding is prompting scientists to rethink the sequence of cosmic structure formation right after the Big Bang.

Today's supermassive black holes, such as the one at the center of the Milky Way (roughly 4 million solar masses), are deeply embedded within large galaxies containing billions of stars, vast gas clouds, and dust. QSO1, by comparison, has an estimated mass of about 50 million solar masses but shows almost no accompanying galaxy: it's surrounding material amounts to far less than half its own mass in gas and dust, with virtually undetectable stellar content and hence termed as nearly naked.

The gas nearby is extremely pristine, composed almost entirely of hydrogen and helium left over from the Big Bang, with negligible traces of heavier elements (metals) that stars would have produced through fusion. This lack of enrichment and minimal host structure gives the black hole its strikingly bare appearance. As Prof. Roberto Maiolino of the University of Cambridge, a key researcher involved, has stated: the object appears to have emerged without a fully developed galaxy preceding it.



Measurements show the black hole mass greatly exceeds any plausible stellar mass component evoking the image of a solitary giant dominating an otherwise sparse environment.

2. Discovery Process:

Astronomers first noticed QSO1 in JWST observations as a faint, reddish point source in a field gravitationally lensed by the massive cluster Abell 2744, which amplified its light like a natural telescope. Initial low-resolution spectroscopy confirmed its nature as an active galactic nucleus powered by a black hole. Deeper follow-up in late 2024, using JWST's NIRSpec instrument in integral field mode, provided high-resolution spectra and pixel-level velocity maps. These data exposed fast-orbiting hot gas in a clean Keplerian disk around a central point source strong evidence for a supermassive black hole rather than, say, a compact star cluster.

The light we detect today left this system when the universe was roughly 700 million years old (over 13 billion years ago), capturing one of the cosmos's earliest epochs.

3. Defying Conventional Models:

Traditional theories hold that black holes begin as the collapsed remnants of massive stars inside forming galaxies, and then gradually increase in size via mergers and slow gas accretion. Yet QSO1's substantial mass and near-total isolation at such an early time make that pathway implausible the universe had too little time for standard growth processes to produce something so large without a substantial galaxy.

JWST surveys have now cataloged hundreds of similar LRDs, suggesting these over massive, isolated black holes may be common in the young universe. Dynamical mass estimates from gas rotation align closely with independent virial methods using emission lines, confirming the black hole's scale and ruling out misinterpretation. Maiolino and collaborators describe this as a true paradigm shift that we are seeing evidence of massive black holes that formed and began accreting with little to no surrounding galaxy.

One compelling hypothesis involves primordial black holes, proposed decades ago by Stephen Hawking. These would arise directly from extreme density fluctuations in the hot, dense plasma fractions of a second after the Big Bang bypassing stars altogether and could grow into super massive sizes by accreting ambient matter.

Alternative ideas include rapid direct collapse of massive primordial gas clouds (possibly aided by early-universe radiation fields) or transient, low-mass host systems that the black hole quickly consumed or expelled. The extremely low metallicity strongly supports origins that avoided significant star formation, tilting the balance toward primordial or near-primordial formation mechanisms.

4. Wider Cosmic Significance:

Observations like this suggest the infant universe was far more dynamic and disordered than standard pictures imply. Black holes could have acted as early gravitational anchors, around which galaxies later assembled—inverting the usual "galaxies first" assumption. This may help explain why JWST keeps finding unexpectedly massive objects so soon after the Big Bang.

Definitive proof of a primordial origin would carry major consequences for fundamental physics, including inflation models, dark matter candidates, and the initial conditions of the universe. Future gravitational wave missions could provide crucial tests.

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Double absorber Perovskite solar cell

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1. Description

The Department of Physics ADP College, Nagaon, Assam in collaboration with Department of Physics North Eastern Regional Institute of Science & Technology (NERIST), Itanagar, Arunachal Pradesh is working on Fabrication and Characterization of Double absorber Perovskite solar cells as a potential sustainable alternative to conventional photovoltaics.

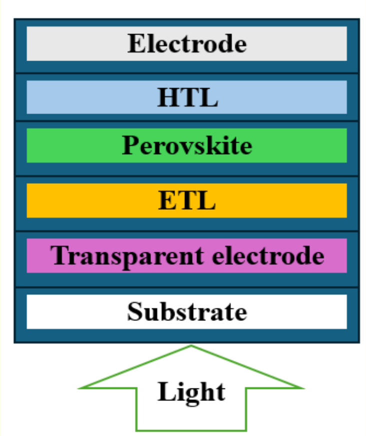

Fig. 1: Components of PSCs

Among the generations of solar cells discovered so far, perovskite solar cells (PSC) have gained attention as an alternative to silicon solar cells due to rapid gains in efficiency and tunability and also help in overcoming traditional barriers of stability, scalability, and toxicity. The device architecture of PSC is glass/FTO (or ITO) / ETL / perovskite / HTL / metal. The perovskites synthesized so far are $MAPbI_3$, $FAPbI_3$, $MASnI_{3-x}Br_x$, $CsPbBr_3$ and $MAPbI_2Cl$. The tunable optoelectronic properties of perovskite absorbers enable efficient light harvesting in ultra-thin films and facilitate tandem architectures for enhanced energy yield. Development of lead perovskite solar cells and their method of disposal have stimulated severe impacts on environmental issues. Furthermore, recent advancements in lead-free tin-based perovskites (e.g., $CsSnI_3$) and double perovskite materials ($A_2BB'X_6$, including Cs_2TiBr_6 and $Cs_2AgBiBr_6$) address environmental and toxicity concerns associated with lead-based systems.

The progress of double absorber has significantly enhanced light absorption across a wider solar spectrum, reduced recombination losses, and improved device efficiency. Recent simulation studies using SCAPS-1D and DFT indicate that optimized double absorber configurations can theoretically achieve efficiencies exceeding 30%, making them a key focus for future photovoltaic research.

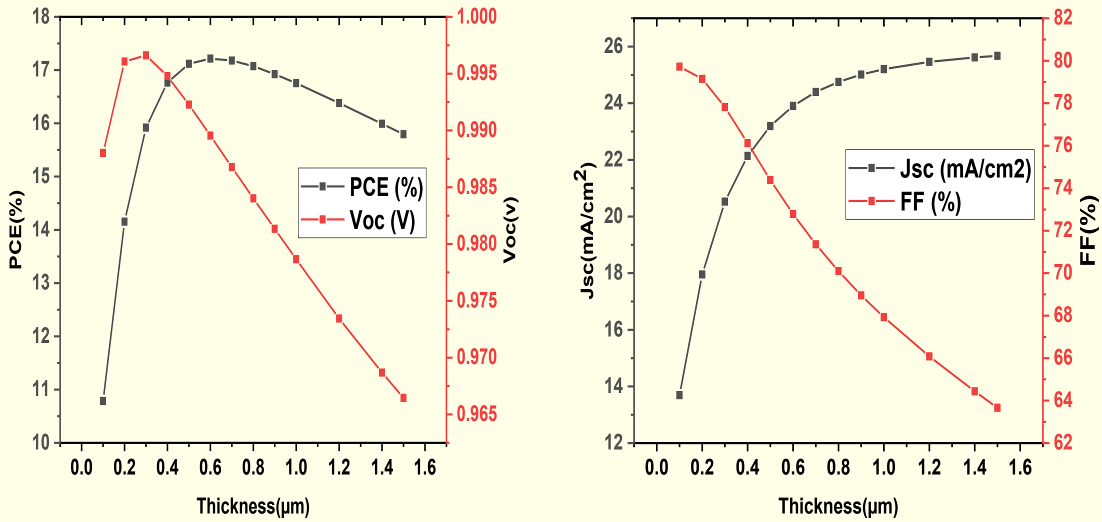

Fig.2: Variation of PCE, Voc, Jsc and FF with respect to thickness of absorber layer of Cs_2TiBr_6

2. References

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Flow Battery Dynamics: Analyzing Performance and Modeling

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1. Description

As the global energy landscape shifts toward renewable sources, managing the intermittency of solar and wind power has become a primary hurdle. Flow batteries have emerged as a highly promising technology for large-scale energy storage due to their long cycle life, reliability, location independence, and scalability. In our latest technical review, we explore the critical performance evaluation methods and advanced mathematical models that are helping to overcome technical barriers and accelerate the widespread commercialization of flow battery technologies. To move beyond the laboratory, flow batteries must undergo rigorous and reliable testing. Our analysis identifies the charge-discharge test as the most effective method for comprehensive performance evaluation. This test primarily assesses four key characteristics, namely (1) Coulombic Efficiency (CE), defined as the ratio of average discharging capacity to average charging capacity;(2) Voltage Efficiency (VE), defined as the ratio of average discharging voltage to average charging voltage, which provides insight into energy losses arising from internal resistance; (3) Energy Efficiency (EE), which represents the overall efficiency of electrical energy conversion and is calculated as the product of Coulombic Efficiency and Voltage Efficiency; and(4) Utilization of Electrolyte (UE), defined as the ratio of actual discharging capacity to theoretical discharging capacity.While charge-discharge tests provide the overall health of the battery, researchers also adapt polarization curvestraditionally used in fuel cell studiesto diagnose specific efficiency losses.Polarization curves help pinpoint three primary mechanisms of voltage loss:

1. **Activation Loss:** Prominent at low current densities, occurring due to the slow kinetics of electrochemical reactions at the electrode surfaces.
2. **Ohmic Loss:** Dominating the mid-region of the curve, arising from resistance to the flow of ions through the electrolyte and electrons through cell components.
3. **Transport Loss:** Evident at high current densities when the mass transport of reactants to the reaction sites becomes a limiting factor.

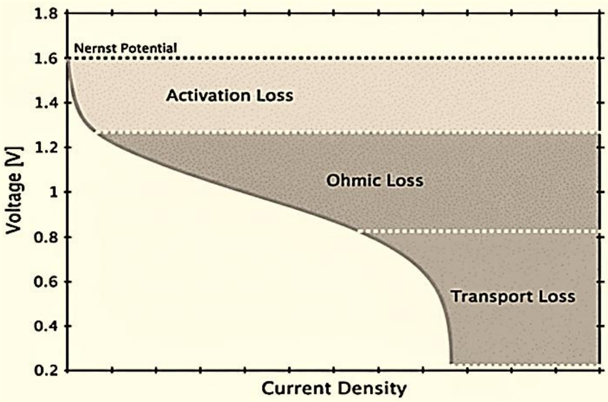


Figure1: Generalized polarization curve for a RFB indicating the dominant source of overpotential in each region.

Because physical experimentation can be expensive and time-consuming, mathematical modeling and simulation play essential roles in understanding the complex electrochemical and transport behaviors within flow batteries.Our research highlights several advanced simulation techniques used to improve the design and performance of flow batteries. These include, (1) Porous-medium models, which employ macroscopic equations such as Darcy's law to describe the superficial velocity of electrolyte flow through porous carbon electrodes; (2) the Lattice Boltzmann Method (LBM), a powerful approach for investigating transport phenomena at the pore scale and understanding how fiber arrangement influences the permeability of porous layers; (3) Molecular Dynamics (MD) and Density Functional Theory (DFT), which provide atomistic-level insight into fundamental chemical interactions, including the effects of counter anions such as sulfate and chloride on the stability of vanadium electrolytes; and (4) stack-level network models, which, despite their simplified nature, are crucial for evaluating overall cell performance, temperature distribution, and system efficiency in practical large-scale applications.

In conclusion, flow batteries present a promising balance of energy efficiency, economic viability, and extended cycle life. Nevertheless, the realization of their widespread commercial deployment will depend on the development of smarter and more highly optimized system designs.Future research must focus on multi-scale modeling that seamlessly integrates micro-scale atomic insights with macro-scale physicochemical processes. By refining redox kinetics and conducting thorough mass and heat transfer investigations, we can extend battery life, reduce costs, and accelerate the global deployment of flow battery technologies.

2. Reference

B. Bora, N. Kalita, and P. Barman, Flow Battery Dynamics: Analyzing Performance and Modeling, *Flow Batteries – Fundamentals, Technological Advancement and Challenges,* Ed: Ram K. Gupta, CRC Press, 2026 [DOI: 10.1201/9781003506379]

➡ Induction of the Fellow of PANE, 2025:

The second edition of the Fellow Induction, 2025, witnessed Prof. Kamalendu Deb Krori being elected as the Fellow of PANE. The election followed a unanimous recommendation by the Scrutinizing Committee of the Fellow of Pane. Prof. Krori, retired Principal of Cotton College and a Life Member of PANE, is among the most distinguished theoretical physicists from Northeast India. Born on 21st January 1930 and soon to turn 96, he has spent more than six decades in teaching, research and institution building, and currently resides in Lachitnagar, Guwahati.

Prof. Kamalendu Deb Krori

PANE Fellows

An alumnus of Calcutta University with a Ph.D. from Jadavpur University, he has authored over 150 research papers and several well-known books, including Fundamentals of Special and General Relativity, Principles of Non-Relativistic and Relativistic Quantum Mechanics, and Advanced Heat and Thermodynamics. He is internationally recognised for the singularity-free Krori–Barua solution (1975) in general relativity, and his work spans rotating universes, scalar–tensor theories, higher-dimensional cosmology, Einstein–Dirac–Maxwell fields and cosmic strings.

Prof. Krori supervised 16 Ph.D. scholars, served one of the longest teaching tenures at Cotton College (later became its Principal), ounded Sankar Academy, and contributed to scientific publishing as an editor of the Indian Journal of Physics. His honours include the Dr. H. C. Bhuyan Award (1990), UGC Emeritus Fellowship (1991–93), National Teacher Award (2010), Vaidya Roychoudhury Award (2010), Academic Physics Prize (2021) and the Asom Sourav (2021). The Assam Science, Technology and Environment Council awarded him the State Science Award for Lifetime Achievement (2022). Remarkably, even last year, at about 95 years of age, he (jointly with Dr. Samrat Dey) rectified a deficiency in the century-old Gamow's theory, the first successful application of quantum mechanics to nuclear physics. The work, published in Resonance, underscores his enduring engagement with academics and research even at this stage of life. A direct student of Prof. S. N. Bose and Prof. M. N. Saha, his election as a Fellow of PANE honours his lifelong contributions to physics and his role in shaping the academic landscape of Northeast India.

The formal induction ceremony will take place during 28th PANE Foundation Day at Gauhati University on 6th April, 2026.

News ...

The Nobel Prize in Physics 2025

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics 2025 to
1. **John Clarke** (University of California, Berkeley, USA) ;
2. **Michel H. Devoret** (Yale University, New Haven, CT, University of California, Santa Barbara and Google Quantum AI, Santa Barbara, CA, USA) ; and
3. **John M. Martinis** (University of California, Santa Barbara and Qolab, Los Angeles, CA, USA)

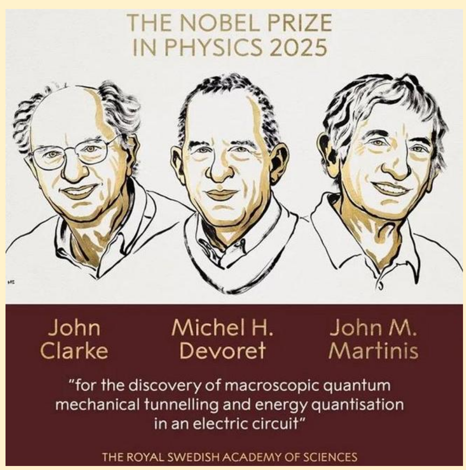
"for the discovery of macroscopic quantum mechanical tunnelling and energy quantisation in an electric circuit".

Their experiments on a chip revealed quantum physics in action. A major question in physics is the maximum size of a system that can demonstrate quantum mechanical effects. This year's Nobel Prize Laureates conducted experiments with an electrical circuit in which they demonstrated both quantum mechanical tunnelling and quantised energy levels in a system big enough to be held in the hand.

Quantum mechanics allows a particle to move straight through a barrier, called tunnelling. As soon as large numbers of particles are involved, quantum mechanical effects usually become insignificant. The laureates' experiments demonstrated that quantum mechanical properties can be made concrete on a macroscopic scale.

In 1984 and 1985, Clarke, Devoret and Martinis conducted a series of experiments with an electronic circuit built of superconductors, components that can conduct a current with no electrical resistance. In the circuit, the superconducting components were separated by a thin layer of nonconductive material, a setup known as a Josephson junction. By refining and measuring all the various properties of their circuit, they were able to control and explore the phenomena that arose when they passed a current through it. Together, the charged particles moving through the superconductor comprised a system that behaved as if they were a single particle that filled the entire circuit. This macroscopic particle-like system is initially in a state in which current flows without any voltage. The system is trapped in this state, as if behind a barrier that it cannot cross. In the experiment the system shows its quantum character by managing to escape the zero-voltage state through tunnelling. The system's changed state is detected through the appearance of a voltage. The laureates could also demonstrate that the system behaves in the manner predicted by quantum mechanics – it is quantised, meaning that it only absorbs or emits specific amounts of energy.

"It is wonderful to be able to celebrate the way that century-old quantum mechanics continually offers new surprises. It is also enormously useful, as quantum mechanics is the foundation of all digital technology," says Olle Eriksson, Chair of the Nobel Committee for Physics. The transistors in computer microchips are one example of the established quantum technology that surrounds us. This year's Nobel Prize in Physics has provided opportunities for developing the next generation of quantum technology, including quantum cryptography, quantum computers, and quantum sensors.



Pic credit : The Royal Swedish Academy of Science

Ref: The Royal Swedish Academy of Science

From The Editor's Desk ...

Events ...

XV^th^ Regular PANE National Conference, 2025

The 15th regular national conference of PANE were held at the Department of Physics, Lumami campus of the Nagaland University during 18-20, November 2025 with Dr. Naorem Shanta Singh and Dr. Vijeth as the event co-ordinators. The 3-day prestigious academic event, which is the first-ever such conference in the state of Nagaland, brought together renowned physicists, researchers, and students from across the region and beyond to delve into the latest advancements and cutting-edge research in the field of physics. The keynote address, as Bipindas Memorial oration, was delivered by Prof. Giridhar U. Kulkarni, JN-CASR, Bengaluru, and former director of the Centra for Nano and Soft Matter Sciences (CeNS), Bengaluru. The plenary talk was delivered by the renowned Indian Scientist, Prof. Vasudeva Siruguri, scientist at the Bhabha Atomic Reseearch Centre and former Director, UGC-DAE-CSR, Mumbai Centre. The conference was also graced by the presence of the eminent speakers including Prof. Sandeep Ghugre, Director, UGC-DAE-CSR, Kolkata centre, Prof. Siddhartha Lal, IISER, Kolkata, Dr. Sapam Ranjita Chanu, IIT-Kanpur, Prof. Madhurjya P. Bora, Gauhati University, and Prof. Angom Dilip Kr. Singh, Manipur University. The inaugural session started with a warm welcome to all the participants and delegates of the PANE-2025 conference by Dr. N. Shanta Singh. Speaking at the inaugural session, chief guest Prof. Jagadish K. Patnaik, Vice Chancellor, Nagaland University appreciated the PANE forum saying that the platform gives opportunity for exchange of knowledge, which in turn fuels scientific advancements. He also stressed the importance of basic sciences in the research and innovation of new technologies for the progress of society. In the opening remarks, Prof Y. Sundarayya, Head of the Department of Physics, Nagaland University, traced the history and growth of the department since its establishment in September 2013. He highlighted the department's steady progress, including securing funded research projects worth 2.5 crore rupees within a decade itself. He also expressed gratitude to the VC of the university for the new science building inaugurated on August 2025 and acknowledged the efforts of university officials and the Registrar, Dr. Abemo, for the support in making the conference possible.

Continued in next page ...

Events ...

Prof Ng. Nimai Singh, President, PANE shared the journey of the organization since its inception in 1997, reiterating its commitment to promoting excellence in Physics across the North East region.He also highlighted PANE's initiatives in recognizing veteran scientists through awards and contributing to academic literature through biannual publications of books and journals. Dr. Samrat Dey, General Secretary, PANE highlighted the organization's wide range of programmes., including school-level outreach, training sessions for high school students, summer and winter schools for undergraduate to Ph.D. scholars, online interviews, conferences, and various fellowship opportunities. He proudly noted that with this event, PANE has now concluded conferences in all seven Northeastern states. Dr. Abemo, the Registrar of the Nagaland University, congratulated the department for conducting the conference and wished a grand success of the scientific meeting. The inaugural session ended with a vote of thanks by Dr. Vijeth.

Earlier, the event coordinators, shared the activities planned for the conference as well as some of the key research areas the department is working. The 3-day conference was sponsored by the North-Eastern Council, Board of Research in Nuclear Sciences, and Indian National Science Academy. In the conference, 60 participants registered for paper presentations (both oral and poster) along with 14 invited talks. The event featured about 120 participants and delegates from different institutions of North-East as well as from other parts of India. Three best Oral and Poster (each) presenters were awarded. Publication of some selected contributed papers is in progress in the journal, 'Journal of Subatomic Particles and Cosmology' (from ScienceDirect.com by Elsevier) and others will be published in the form of book chapters. The 16th regular national conference of PANE, will be held at Bodoland University, Kokrajhar, Assam in the year 2026.

News ...

New PANE Website

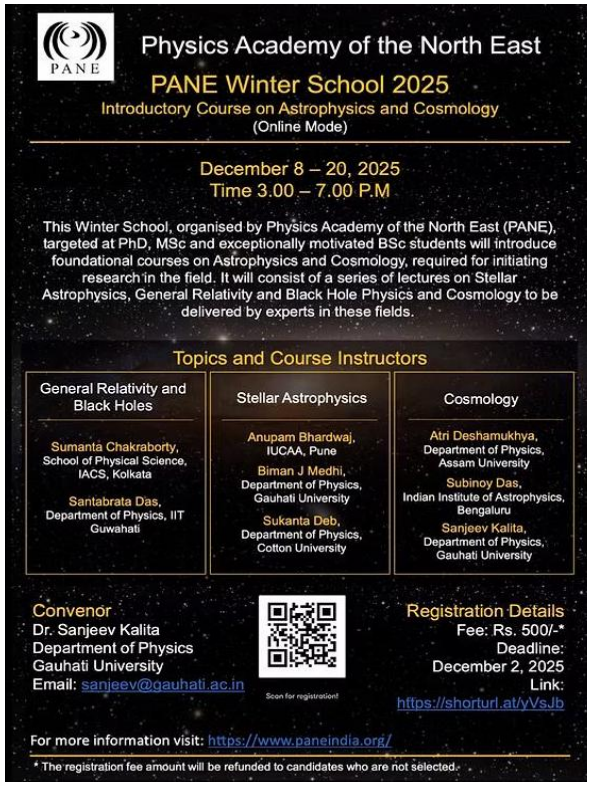
To oversee the design and long-term management of the PANE website, the newly formed subcommittee titled "PANE Website Design and Management Committee" came up with new PANE website under the co-ordinatorships of Mr. Himanshu Bora and Dr. Anshuman Baruah. The wesite address is - *https://www.paneindia.org/* with the fresh looking updated and interactive interface, completed at a reasonable cost. An article on PANE has been created in Assamese and Bengali Wikipedia (*https://w.wiki/K6iQ*). This is known as PANE Wikipedia page.

Winter School on Astrophysics and Cosmology

The PANE Winter School 2025 - Introductory Course on Astrophysics and Cosmology - was successfully organised by PANE from 8 to 20 December 2025. The daily schedule from 3:00 PM to 7:00 PM was designed to facilitate the participation of graduating students, enabling them to attend the sessions after regular academic hours.

The Winter School was convened by Dr. Sanjeev Kalita and was aimed at PhD scholars, MSc students, and exceptionally motivated BSc students. The course was structured to introduce the foundational concepts of Astrophysics and Cosmology essential for initiating research in these areas. The academic programme comprised a series of expert lectures covering Stellar Astrophysics, General Relativity and Black Hole Physics, and Cosmology, complemented by several interactive tutorial sessions to enhance conceptual understanding and student engagement.

The lectures were delivered by experts in these fields, including: Dr. Sumanta Chakraborty, IACS; Prof. Santabrata Das, IIT Guwahati; Dr. Anupam Bhardwaj, IUCAA; Dr. Biman J. Medhi, Gauhati University; Dr. Sukanta Deb, Cotton University; Prof. Atri Deshamukhya, Assam University; Dr. Subinoy Das, IISc; and Dr. Sanjeev Kalita, Gauhati University.



The Winter School witnessed enthusiastic participation from about 100 students and researchers drawn from various parts of India, reflecting the growing interest in Astrophysicsand Cosmology among young scholars. To support effective learning, study materials and recorded lecture videos were provided to all participants at the end of each session. The programme was widely appreciated for its academic depth, clarity of presentation, and interactive format, and it contributed significantly to capacity building in frontier areas of physics in the North Eastern region and beyond.

News ...

⟶ Inaugural edition of Young Scientist awards

2026 will witness the inaugural edition of conferring the Young scientist awards in the next upcoming 28th Foundation day of PANE along with the felicitation of senior female scientists of North East. The Committee members went through all the nominations and supporting material, and invited each of the nominees to make a presentation to the Committee on the 25th and 26th of March 2026 on one of their research topics which they consider to be their best and most significant one. The presentations were for about 30 minutes each, including discussions and questions and answers. Based on an overall assessment of their contributions, and their presentations, the Advisory Committee's recommendations went as: PANE Young Scientist Award 2026 goes to -

Jitumani Kalita and **Devabrat Mahanta**

Upcoming Events ...

⟶ 28th Foundation Day of PANE

28th PANE Foundation Day ceremony of Physics Academy of North East (PANE) will be organized jointly by the Department of Physics, Gauhati University (GU), Guwahati, and PANE, to be held on 6th April, 2026 (Monday) at Physics Gallery, Department of Physics, GU. The event will feature distinguished dignitaries, including the Vice Chancellor of GU as the Chief Guest. A special highlight of the day will be the Foundation Day Lecture by Prof. Bhupendra Nath Goswami. This year's celebration will be historic as it will award the inaugural edition of the Young Scientist award by the academy; launch the academy's new journal, the PANE Journal of Physical Education; distribute prizes to the toppers of the North East India Physics Talent Search 2025, felicitate eminent women physicists, Prof. Joyanti Chutia, Prof. Kalyanee Boruah & Prof. Pranayee Datta, for their contributions to physics teaching and research; and will also present the list of PANE Fellows of 2025 along with the appointment procedure for new Fellows of PANE.

⟶ Launch of new PANE Journal

PANE, guided by its core philosophy of 'Promotion of Physics Education and Research in North-East India', is launching the **"PANE Journal of Physics Education"**, a peer-reviewed e-journal devoted to publishing original, high-quality research articles on the teaching and learning of physics on 6 April 2026, the Foundation Day of PANE. With only a limited number of pedagogical journals in physics—apart from the American Journal of Physics and the European Journal of Physics—the long-felt need for such a platform was recognized by the Executive Body of PANE. The PANE Journal of Physics Education will feature contributions on classroom and laboratory instruction, original insights into derivations in classical and modern physics, apparatus notes, and historical or cultural perspectives, all aimed at sustaining and enhancing the quality of physics education in colleges, universities, and other higher-education institutions. Manuscripts submission guidelines are available in the website *https://journals.paneindia.org/index.php/pjpe*. It is a significant step toward fulfilling PANE's broader objectives.

⟶ XVIth PANE Conference 2026

The XVIth Regular PANE Conference (RPC), proposed to be held in 2026, will be organised by the Department of Physics, Bodoland University, Kokrajhar, Assam by the month of November, 2026 (exact dates yet to be finalised). As per the information given by the faculty member of the Bodoland University, Prof. Heremba Bailung to the Executive Body, the preparations for the conference are underway, and the Vice Chancellor of Bodoland University has assured his full support for the event. The Organizing committee for the conference and the appropriate publisher for the conference proceedings will be updated very soon. As per the news, the process has already begun for the formation of the various committees for the conference as discussed in the last executive meeting of PANE held on 11th February, 2026. The first announcement along with the conference flyer/brochure will be releasing very soon. The Conference Registration Fees for PANE Life Members will be charged at concessional rates, as was done in the last two conferences. For more details, keep browsing the official PANE website provided in the header of this page.

Events ...

⟶ International Conference on Sustainable Environment, Energy and Biosciences (ICSEEB 2026)

The Department of Physics, ADP College, Nagaon successfully organized the first International Conference on Sustainable Environment, Energy and Biosciences (ICSEEB 2026) on March 6 & 7, 2026, marking a significant milestone in promoting interdisciplinary research and dialogue on sustainability. The conference was organized in collaboration with Gauhati University, Assam Pollution Control Board, Assam State Disaster Management Authority, and Assam Climate Change Management Society. It received sponsorship from the Department of Science and Technology (ANRF-DST), the Council of Scientific and Industrial Research (CSIR), Government of India, and Numaligarh Refinery Limited (NRL). The event was jointly convened by Dr. Lakshmi K. Singh (Department of Physics), Dr. Mousumi Saikia (Department of Herbal Science & Technology), and Dr. Afifa Kausar (Department of Zoology). Dr. Lakshmi K. Singh, PANE Life member: LM-0276 served as the organizing secretary of the conference.

Dr. Sadananda Payeng, Chairman of ICSEEB-2026, and Principal of the College delivered the welcome address, Dr. Lakshmi K. Singh outlined the objectives and journey of organizing the conference. Dr. Arup Kumar Misra, Chairman of the Assam Pollution Control Board, addressed the gathering, emphasizing the importance of environmental conservation and policy. Prof. Ruben Tatevossian and Prof. Vera Bykova, both from the Institute of Physics of the Earth, Russian Academy of Sciences, Moscow, Russia, highlighted global perspectives on seismic hazards and sustainability. The keynote address was delivered by Prof. Sebastiano D'Amico, University of Malta, Malta, on sustainable groundwater resource management using advanced geophysical techniques.

The two-day conference featured around 25 invited talks from India and abroad, 74 oral presentations, and 46 poster presentations, covering key themes such as climate change, renewable energy, biodiversity, advanced materials, biotechnology, and environmental policy. The Best Poster Award was jointly awarded to Shreya Borah (ALBA Synchrotron Light Source, Spain) and Nityanand Bhuyan Mathew (ADP College). ICSEEB 2026 concluded on March 7 with a valedictory session, certificate distribution, and award announcements. The conference served as a vibrant platform for researchers, academicians, and industry experts to exchange ideas and strengthen collaborations toward sustainable development.

Editor's Desk

"Physics at the Crossroads: Knowledge, Responsibility, and the Future of Humanity"

Physics has long been celebrated as the science that unravels the secrets of the universe. From explaining the dance of celestial bodies to unlocking the mysteries of atoms, it inspires curiosity, innovation, and progress. Yet today, as we witness the alarming escalation of destruction in conflict zones—especially in the Middle East—we are confronted with an uncomfortable truth: the same physics that powers medical imaging, renewable energy, and space exploration also fuels missiles, drones, and weapons systems.

This duality forces us to ask a painful question: *Are we learning physics to understand nature—or to perfect the tools that destroy humanity?* The purpose of knowledge seems to blur when scientific brilliance becomes intertwined with human suffering. Every time a student learns about Newtonian laws of motion, force, energy, gravity, projectile, relativistic speed, hypersonic, electronics, electromagnetic field, fluid matter or the behavior of matter, we imagine a future innovator or educator. But modern warfare shows a disturbing parallel path: the application of these very principles to amplify violence with unprecedented precision. Physics was meant to reveal beauty—the elegance of equations, the symmetry of nature, the harmony of cosmic laws. But when the same knowledge becomes the foundation for advanced weaponry, our moral compass must question its direction.

The devastation witnessed across conflict zones makes us pause and wonder: *Where did the purpose of learning go wrong?* Physics itself is not to blame. *Science is neutral; its application is not.* What we choose to do with knowledge reflects our values, not the equations we study. But when the consequences of misapplied knowledge become as visible—and devastating—as they are today, the scientific community cannot remain silent. This is why institutions like the Physics Academy of North East must reclaim the moral narrative of science. We must teach physics with purpose, with conscience, and with an unwavering commitment to humanity. Our classrooms must not only illuminate the elegance of equations but also instill the responsibility that comes with power. We must remind our students that every scientific insight can either heal or harm, uplift or destroy. Students must learn that every scientific breakthrough carries ethical weight. The world stands at a crossroads. Knowledge can deepen compassion or amplify conflict. The direction depends on the hands that wield it. Let us reaffirm our mission: to nurture a generation of physicists who choose creation over destruction, progress over power, and peace over violence. Physics must remain a tool for understanding the world—not for tearing it apart. The responsibility is ours. The future is, too.

"Long Live Physics for Progress….."

অসম চৰকাৰ

सत्यमेव जयते

GOVERNMENT OF ASSAM

CERTIFICATE OF REGISTRATION OF SOCIETIES ACT XXI OF 1860

Issue No. : **202501848**

UBIN: **618/140367/AXJPD3820F/8/2025**

UAIN : **RFS-RRS/2025/01848**

Registration No. : **RS/KAM/240/J/36 of 2000-2001**

I hereby Certify that **PHYSICS ACADEMY OF THE NORTH EAST, Village/Town/City - Inadian Institute of Technology IIT, Panbazar, Post Office - Panbazar, Police Station - Panbazar, Dist. - KAMRUP METRO, Pin - 781001** has this day been registered under the Societies Registration Act XXI of 1860.

Given under my hand at GUWAHATI on this **29/06/2000**

VALID UPTO: **29/06/2003**
VALIDITY EXTENDED UP TO: **04-09-2028**

The renewal of the society is approved on **05/09/2025** by **Arup Kumar Sarma, REGISTRAR OF SOCIETIES,ASSAM, GUWAHATI**

Digitally signed by ARUP KUMAR SARMA
Date:2025.09.05 07:15:06 +05:30

Place of issue: **GUWAHATI**
Date of issue: **05/09/2025**

H N Bhuyan
REGISTRAR OF SOCIETIES
GUWAHATI, ASSAM

N.B.:- Registered number of Societies should not be stated as Government registered. It is registered under S.R.Act, XXI of 1860.

"Please read carefully the rules written overleaf."

*****This certificate can be verified by Application Ref. No or the QR Code printed on it.*****

PANE NEWSLETTER

Snippets from Print Media in North East

PANE's 67th foundation day celebrated

GUWAHATI, April 8: The 67th foundation day of Physics Academy of the North East (PANE) was celebrated on Monday in the KBR Auditorium of Cotton University, Guwahati, stated a press release.

The foundation day lecture was delivered by Prof Soumita Sengupta, Amal Kumar Raychoudhury Chair Professor at IACS, Kolkata on the topic 'Quantum Mechanics in Gravity.'

Prof Ramesh Chandra Deka, vice chancellor of Cotton University, attended the occasion, along with other dignitaries like Prof N Nimai Singh, Prof JJ Das, Prof Kushal Kalita, Dr Samrat Dey and Dr Pranab Jyoti Bhuyan.

During the programme, Prof Pabitra Borgohain, Prof Barindra Kumar Sarma, Prof Amarendra Rajput and Prof PK Baruah were felicitated for their contributions to physics teaching and research.

The first issue of the *PANE Journal of Physics*, edited by Dr Debasish Borah of IIT Guwahati and Dr Debajyoti Dutta of Bhattadev University, was released. The PANE newsletter, edited by Dr Nabendu Deb, was also released on the occasion.

Toppers of the North East India Physics Talent Search (NEIPTS) 2024 examination were felicitated during the programme. Dibya Priyam Saharia of Ramanujam Academy Senior Secondary School, received the first prize.

THE ASSAM TRIBUNE, GUWAHATI 3
MONDAY, SEPTEMBER 15, 2025

NEIPTS 2025 exam on Nov 9

GUWAHATI, Sept 14: The Physics Academy of the North East (PANE) will conduct the second edition of the North East India Physics Talent Search (NEIPTS) 2025 Examination on November 9 for students of Classes 9 to 12, a press release stated.

The test, aimed at identifying young physics talents from across the region, will be held in nearly 50 centres. Registration is open at paneindia.org until October 5. Registered candidates will also receive pre-exam mentoring from faculty of IITs, universities, and other institutions.

The first phase will be an MCQ-based exam. From this, 100 students – comprising the top 10 from each of the eight northeastern states – will qualify for the second phase, an interview round. Finally, 10 students will be named Northeast Toppers, earning certificates, cash prizes, and reimbursement of the National Standard Examination in Physics (NSEP) 2025 fee.

THE ASSAM TRIBUNE, GUWAHATI 7

NE Physics body meet held at Nagaland University

GUWAHATI, Nov 26: The 15th edition of the Physics Academy of the North East (PANE) conference was held from November 18 to 20 at the Lumami campus of the Nagaland University, a press release stated.

The Bipinpal Das Memorial Ovation was delivered by Prof GU Kulkarni, former president of JNCASR, Bengaluru, and former director of the Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru. Prof Vasudeva Siruguri, scientist at the Bhabha Atomic Research Centre and former Director, UGC-DAE-CSR, Mumbai centre, Prof Sandeep Ghugre, Director, UGC-DAE-CSR, Kolkata centre, Prof Siddhartha Lal, IISER, Kolkata, Dr Sapam Ranjita Chanu, IIT-Kanpur, Prof Madhurjya P Bora, Gauhati University, and Prof Angom Dilip Kumar Singh, Manipur University, attended the conference.

The three-day conference was sponsored by the North-Eastern Council, Board of Research in Nuclear Sciences, and Indian National Science Academy.

Speaking at the inaugural session, chief guest Prof Jagadish K Patnaik, VC, Nagaland University, stressed the importance of basic sciences in the research and innovation of new technologies for the progress of society. In his opening remarks, Prof Y Sundarayya, head of the Department of Physics, traced the history and growth of the department since its establishment in 2013.

Prof Ng Nimai Singh, president of PANE, shared the journey of the organisation since its inception in 1997, reiterating its commitment to promoting excellence in Physics across the North East region. Dr Samrat Dey, general secretary of PANE, highlighted the organisation's wide range of programmes.

The conference featured 14 invited speakers, 40 oral presentations, and 20 poster presentations, the release added.

THE ASSAM TRIBUNE, GUWAHATI 5
SUNDAY, NOVEMBER 30, 2025

Prof Krori elected PANE fellow

GUWAHATI, Nov 29: Eminent physicist Prof KD Krori has been elected as a Fellow of the Physics Academy of the North East (PANE).

The Academy announced the election of Prof Krori, a former Principal of Cotton College on Saturday, a press release stated. The decision follows a unanimous recommendation by the scrutinizing committee – comprising members of at least one of the three Science Academies of India – and an affirmative vote from all Fellows who participated in the process.

He is widely regarded as one of the most distinguished theoretical physicists to emerge from the region. Born on January 21, 1930, he has devoted more than six decades to teaching, research and institution building. A life member of PANE, he currently resides in Lachitnagar.

E ASSAM TRIBUNE, GUWAHATI
ONDAY, MARCH 30, 202

Two physicists to get PANE Young Scientist award

GUWAHATI, March 29: The Physics Academy of the North East (PANE) has announced the recommendations of the Advisory Committee for the PANE Young Scientist Award 2026 and the PANE Woman Scientist Award 2026.

The Advisory Committee, comprising a former Vice-Chancellor, a former Director of a national institute, and other senior physicists, has recommended that the PANE Young Scientist Award 2026 be shared equally between Dr Jitumani Kalita (Assitant Professor, Cotton University) and Dr Devabrat Mahanta (Assistant Professor, Pragjyotish College), a press release stated.

Based on an overall assessment of the nominees' research contributions, presentations, and the discussions that followed, the committee recommended that the Young Scientist Award be jointly conferred on the two physicists. The committee also recommended that no award be given for the PANE Woman Scientist Award 2026.

The awards are expected to be presented during the upcoming 28th foundation day celebration of PANE, to be held at Gauhati University on April 6.

The Assam Tribune Date 6 May 2025

Summer school on high energy physics

GUWAHATI, May 5: Physics Academy of the North East (PANE) is organising a summer school on 'foundational course on high energy physics' from June 2-14.

The school is intended for PhD, MSc, highly motivated undergraduate students, and other physics enthusiasts, stated a press release. The school will be held in online mode from 3 pm to 7 pm.

Prof Subhaditya Bhattacharya, and Dr Debasish Borah of IIT Guwahati, Dr Prabwal Phukan of Dibrugarh University, Dr Tirtha Sankar Ray of IIT Kharagpur, and Prof Joydeep Chakraborty, Dr Sabyasachi Chakraborty of IIT Kanpur are among the course instructors.

According to the press release, the school will help young researchers and students to strengthen their foundational knowledge in topics such as quantum field theory, group theory, gauge theory, and standard model and beyond.

Interested candidates can register themselves before May 20 by visiting paneindia.co.in, the release added.

Search exam on Nov 9 in Shillong, Tura

Shillong Times espondent

SHILLONG, Sep 16: The Physics Academy of the North East (PANE) will conduct the second edition of the North East India Physics Talent Search (NEIPTS) 2025 examination on November 9 for students of Classes 9 to 12. The test, aimed at identifying young physics talents from across the region, will be held in nearly 50 centres.

For candidates from Meghalaya, Don Bosco College, Tura, and Shillong College have been designated as the examination centres. Registration is open at paneindia.org until October 5. Registered candidates will also receive pre-exam mentoring from faculty members of IITs, universities and other institutions.

"The first phase will be an MCQ-based exam, -

(Contd on P-7)

(Contd from P-3) from which 100 students, comprising the top 10 from each of the eight Northeastern states, will qualify for the second phase, an interview round," the statement said.

"Finally, 10 students will be named Northeast Toppers, earning certificates, cash prizes and reimbursement of the National Standard Examination in Physics (NSEP) 2025 fee," it added.

PANE
www.paneindia.org

STAGES OF THE EXAM

Stage-I: MCQ based

- Selection of 10 Centre Toppers from each centre.
- Selection of 10 State Toppers from each state.
- Selection of 100 Finalists including State Toppers.

Stage-II: Interview

- Selection of 10 NE India toppers.

ADVANTAGES

- Pre-examination teaching to clarify physics concepts (by teachers of IITs, Universities and other HEIs)
- MCQ based exam modeled on national/ international level competitive examinations.
- Selection of Centre Toppers and State Toppers.
- Cash awards for North East India Toppers.

Physics Academy of the North East

presents the 2nd edition of the

North East India Physics Talent Search

NEIPTS 2025

Examination

(For Students of Classes IX, X, XI & XII)

Exam Date November 9 2025

More than 50 Centres Across North East

Application Last Date October 5 2025

Examination Fees for NSEP 2025 regarded as the

National Physics Olympiad

the only qualifying examination for the

International Physics Olympiad

will be reimbursed to the *North East India Toppers* of NEIPTS 2025 along with guidance for the same.

APPLY NOW
Register here

ta, Publicity Secretary, PANE; Email: yajnya@dudhnoicollege.ac.in; Ph. No. 6291762473

THE ASSAM TRIBUNE, GUWAHA
UNDAY, FEBRUARY 15, 2026

Nominations invited for young scientist, woman scientist awards

GUWAHATI, Feb 14: The Physics Academy of the North East (PANE) has invited nominations for the PANE Young Scientist Award and the PANE Woman Scientist Award, 2026. The last date for submission of nominations is February 28, stated a press release received here.

The awards aim to recognize outstanding contributions in Physics by young scientists and women scientists who are either born in the North Eastern region or have been continuously engaged in scientific work in the North East for at least five years. Nominees must fulfil the prescribed eligibility criteria, including significant research contributions and publications. The details are available in the PANE website.

Nominations may be submitted by the candidates themselves or by others, and forwarded by head of an institution or a fellow of NASI, INSA, IASc, or PANE, the release said.

8 THE ASSAM TRIBUNE, GUWAHATI
WEDNESDAY, JANUARY 28, 2026

State student tops talent search exam

GUWAHATI, Jan 27: Ayudh Baruah of Salt Brook Academy, Dibrugarh, topped the prestigious North East India Physics Talent Search (NEIPTS) 2025 Examination conducted by the Physics Academy of the North East (PANE), stated a press release received here.

The results of the exam were declared on January 22. The examination was held in two stages. The first stage, an MCQ-based test conducted on November 9 across nearly 50 centres in the North East, was open to students of Classes IX-XII. In the final stage, all finalists, including state toppers were interviewed, and the top 10 students from the North East were chosen.

Samiran Hazarika of Dr Radhakrishnan School of Arts, Commerce and Science, Dibrugarh, and Rajkumar Prithviraj Sana of St Edmund's School, Shillong, secured the second and third positions respectively.

All toppers and outstanding performers will be felicitated and presented with cash awards, the release further said.

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PANE

Promoting physics education and research in North-East India since 1998

Social Media :

: www.youtube.com/@PANEINDIA

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